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MANY-TO-MANY COMMUNICATION

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Center for Information Systems Research

Sloan School of Management

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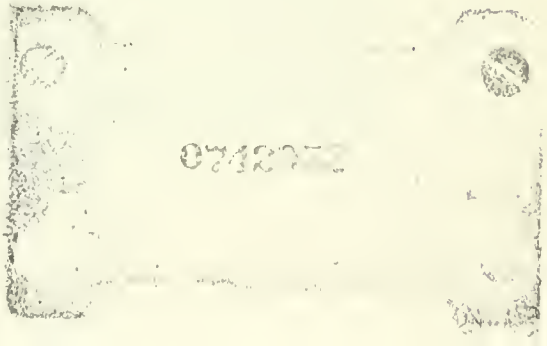
ABSTRACT

Networking among people is not new, but, when supported by new computer networking, unprecedented many-to-many communication results. When computer storage and branching capabilities are used to filter communications so as to better match personal interests, then one-to-one electronic mail and one-to-many mass media become less significant than interactive media — that is, many-to-many communication.

Three new forms of many-to-many communication are described. First, there is inquiry networking. Brief inquiries are communicated to many, responded to by some, and joined as "inquiry nets" by as many as may be interested. Second, there is dialogue balloting, which uses electronic voting, not to decide issues as in elections but just to help structure group dialogue so that discussion branches taken are of the most interest to the most people. The third form is interactive graphics, which serves as a "graphic" language for many-to-many communicatiion. Interactive graphics supplements the "textual" language of inquiry networking and the "quantitative" language of dialogue balloting.

This concept paper advocates new research to yield improved designs for systems to support many-to-many communication. Future impacts of this new technology on people, organizations, markets, politics, and society as a whole should be studied. If managed well, many-to-many communication could dramatically improve productivity and innovation.



1. PREFACE

Although the author takes responsibility for this paper's explanation of the concept of "many-to-many communication," he cannot take credit for the emergence of this concept. Many people were invclved in developing the "many-to-many" concept as presented herein -- by, in fact, using "many-to-many" techniques in developing that very concept.

This paper focuses on:

A) analyzing technological developments, particularly in computers, that have given rise to the concept of many-to-many communication;

B) providing illustrations of how new computer technology makes many-to-many communications available to supplement older forms of communicating one-to-one (e.g., personal letters and phone conversations) and one-to-many (e.g., junk mail and mass media);

C) projecting how many-to-many communication might affect organizations and society as a whole.

The purpose of this concept paper is to stimulate new research initiatives. Much of the research needed is expected to take the form of case studies of early uses of rapidly emerging "many-to-many" technologies.

Networking to share R&D ideas, not surprisingly, is practiced among those working to provide technological support for many-to-many communication. To encourage and strengthen such networking among "many-to-many" R&D people, a new research consortium is being formed. This consortium, which has taken root in MIT's Center for Information Systems Research, already has branched to include a number of researchers based in other MIT research centers and labs concerned with

different aspects of many-to-many communication. In true networking fashion, this consortium also extends its network beyond the boundaries of MIT (aided in part by computer-based communications, of course) to include various dispersed researchers and research organizations.

It is our hope that the scholars and practitioners who will soon compose this new R&D consortium, will quickly help fill many of the research gaps identified in this concept paper. My own professional experiences which have most influenced this paper are as follows:

1. Upon entering the computer field 25 years ago with IBM, I became interested in how computers might increasingly augment rather than replace human information processing capabilities.

2. In the late fifties, as head of a small system programming group at the U.S. Air Force's Pentagon Computer Center, I observed limits on what computers can do when I assisted Georgetown University's language translation group.

3. In the sixties, as the first Independent to be elected to the Massachusetts legislature in fifty years, I was forced to devise non-traditional forms of communications in order to interact with voters not otherwise accessible to me through normal party channels.

4. After receiving a Ph.D. in economics (see reference to dissertation in Section 7 of this paper) in 1967, I taught at Brandeis University, MIT's Sloan School of Management and Rensselaer Polytechnic Institute and served as Science Advisor to the Governor of Puerto Rico, where we developed various systems to help government "listen better both to science and to citizens."

5. In 1970, I founded Participation Systems Incorporated (PSI). In 1974, I left academia to work full-time through PSI in applying what I now see as techniques to support many-to-many communication. Most of the PSI work in the 1970's took place in the public sector. Case examples cited in this paper are drawn from those experiences.

6. In 1980, I returned to academia as a part-time consultant to MIT's Center for Information Systems Research (CISR), whose decision support systems work seemed like a natural context in

which to consider how PSI's public sector experiences might be applied more within the private sector. As a consultant to CISR, during the past several months, I have made presentations, conducted interviews and made informal surveys of both potential users as well as potential suppliers of support systems for many-to-many communication.

7. An informal group of approximately a dozen people at MIT and from corporations around greater Boston met four times, approximately monthly, to help define this field and initiate R&D to assist private firms as well as government agencies. Their fourth meeting included **many** more persons, approximately four times the number of people (about 50 compared to the 12 previously), largely because techniques of **many-to-many communication** were used to involve more people. In particular, prior to that meeting a computer conferencing system known as EIES (Electronic Information Exchange System) carried a summary of this paper, which was discussed by several people through that medium when they were asked to answer eight questions in exchange for later being sent the full paper, now being written. A few of those who commented on EIES then decided to come to MIT to discuss this subject further at the above mentioned meeting, which was eventually extended to an afternoon "networkshop" (employing other many-to-many communication techniques) for those who stayed.

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I. INTRODUCTION

1. COMPUTER SUPPORT FOR NETWORKING AMONG PEOPLE
An Old Concept Given New Support and New Significance

Many-to-many communication, technologically supported by computer networking, is essentially a new phenomenon. It stems, though, from earlier social networking, which people have been doing ever since they first began walking around and talking to each other.

Many-to-many communication is more formal and generally faster than older forms of social networking. Newly available computer-based communications allow many persons to communicate with many by using computer memory and branching capablities to organize communication flows, satisfying both senders and receivers on a more collective basis than previously possible.

In the seventies, we were able to experiment with new techniques of many-to-many communications, but only on a relatively small scale. Now, in the eighties, because computer networking is spreading rapidly, we need to shift our research attention more toward assessing what impact these techniques may have when applied on a widescale basis.

Is information, like matter and energy in earlier eras, only now starting to become a fundamental economic commodity? Prior to this Communication Era, was the growth of large bureaucracies, particularly to service non-economic or politically-defined needs, inevitable? How might many-to-many communication alter politics as well as markets and organizations? Is this particular transformation already under way? Will a more careful examination of the implications of unprecedented forms of many-to-many communication help us understand present changes as well as prepare us better for more substantial changes in future years? And, finally, why should such questions be posed unless we first have indications that there are promising ways of finding answers?

In this concept paper, we can only suggest how such answers might be obtained. For example, in Part III we will briefly consider how networking may supplement hierarchical coordination and thereby substantially improve productivity and innovation. But, first in Part II, we will consider specific techniques designed with such improvements in mind, after those new techniques in the next section are introduced within the context of more familiar computer practices.

2. FROM DATA PROCESSING TO WORD PROCESSING AND BACK
Where "Many-To-Many" Fits in the Textual to Quantitative Spectrum

There must be an appropriate balance between the familiar and unfamiliar in any message in order for it to convey meaning. The familiar content allows one to integrate what is unfamiliar into one's existing knowledge base. Therefore, computer-based communication systems have been at first called by familiar names used to describe older forms of communication such as "mail," as in "electronic mail," and "conference" in the phrase "computer conference." However, the inherent capabilities of the computer to help organize communications go well beyond speeding up the mail electronically and well beyond allowing sequential conference commenting to take place over long distances as well as over extended time periods.

No matter how fast mail can be sent electronically, mail is inherently a form of either one-to-one communication, as in the case of individualized letters, or else one-to-many communication, as in the case of form letters, periodicals, junk mail, etc. Computer conferencing comes closer to achieving a form of many-to-many communication. However, overload easily creeps into computer conferences just as it does in face-to-face conferences when sequential comments become less relevant to the interests of particular participants.

Systems which start off being called electronic mail or computer conferencing acquire attributes not available in earlier mail or conference modes from which they derive their names. For example, an item of electronic mail, with very little effort, could be answered immediately upon receipt, simply because the computer delivering it could remember where it came from, even if the sender chose to hide his or her identity behind a pen name. That option, to "answer," if offered in any electronic mail system, would give that medium more of an

interactive quality than has traditional mail, while pen names that can be answered would provide an option or attribute not even present in most non-electronic mail systems.

As another example, computer conferences generally have moderators or organizers acting mainly as gatekeepers to determine who can join, and as editors to modify or delete comments that may be judged as inappropriate, off the subject, or eventually obsolete. A variation of computer conferencing, described in the next section of the paper, is called "inquiry networking." There the moderator as gatekeeper becomes an inquirer, which is quite distinct from the role as editor.

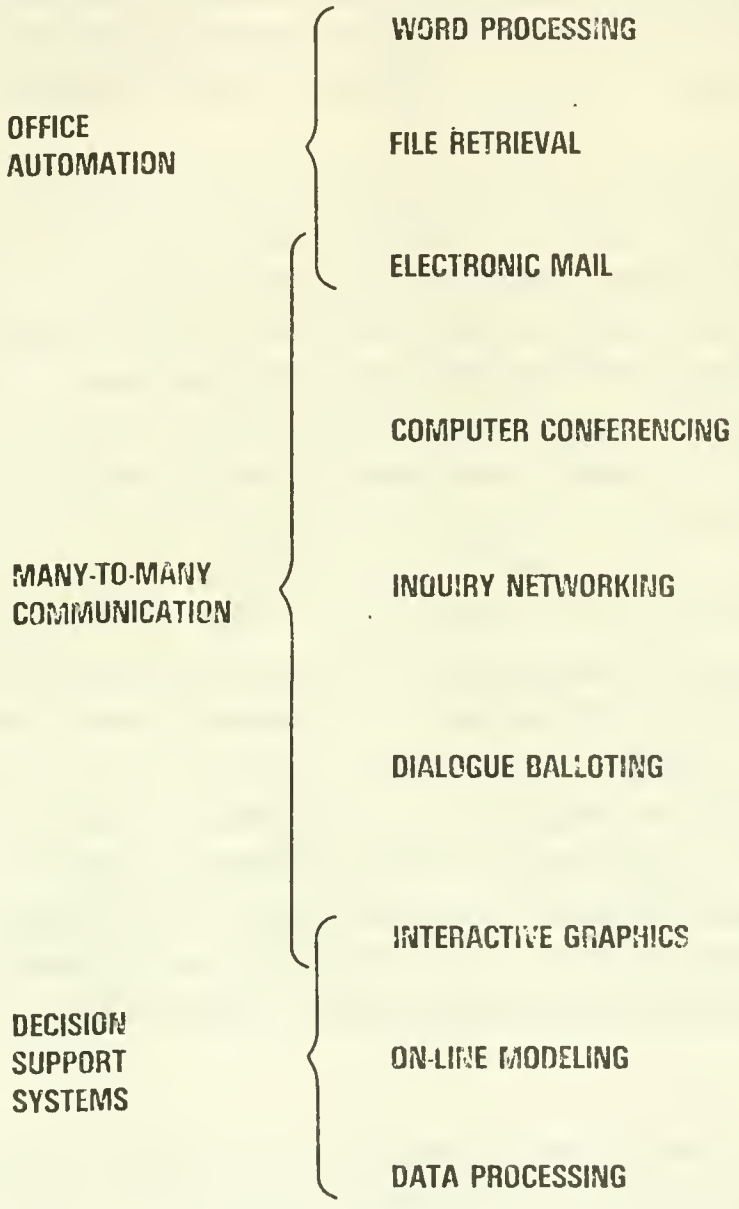
Inquiry networking is less familiar than either electronic mail or computer conferencing. Inquiry networking is an extension of electronic mail and computer conferencing. It uses the computer's fundamental capability of branching to allow many-to-many communication to take place without producing information overload.

The field of computer usage today is concerned not only with traditional data processing but also with the newer field of word processing. Out of data processing has developed what is now well known as decision support systems. And, in close asssociation with word processing, there is the equally popular office automation.

Inquiry networking falls in between office automation, in one end of the spectrum of computer usage, and, at the other end of the that spectrum, decision support systems. This spectrum can best be characterized as being textual at one end and quantitative at the other end. In the middle we find inquiry networking along with related computer-based communication forms such as electronic mail, computer conferencing, dialogue balloting and interactive graphics. In Exhibit 1 these latter four, along with inquiry networking, are characterized as variations of many-to-many communication.

EXHIBIT 1

SPECTRUM OF COMPUTER USAGE
TEXTUAL TO QUANTITATIVE



While inquiry networking is more structured than electronic mail and computer conferencing, it is less structured than dialogue balloting and interactive graphics. Through dialogue balloting, participants in many-to-many communication "vote," not to bind each other to any long-term group position but simply to help guide their dialogue over the short-term. Dialogue balloting introduces a quantitative element, the count of votes, into what otherwise might be primarily textual dialogue.

Of course, many-to-many communication may include the exchange of quantitative as well as textual information. For this reason, as well as for the display of dialogue balloting results, computer graphics are important in support of many-to-many communication. As in the field of decision support systems, those computer graphics are "interactive" in that human interaction with the computer typically modifies what graphic display appears. The graphic representations that best support dialogues or decisions usually require on-the-spot applications of human judgment. The main difference in the interactive graphics used in many-to-many communication as compared to decision support systems is in how that human judgment is applied. In many-to-many communication, judgment is applied collectively through dialogue balloting rather than individually by a single decision-maker interacting with the computer. For example, the subjective weights applied to the objective function within a mathematical model could be determined through electronic voting by a group wanting to use that model to make projections.

Other examples of many-to-many communications besides those shown in Exhibit 1 could be given. For instance, interpersonal scheduling, as an extension of keeping personal calendars on computers, could be considered as a form of many-to-many communication developed to facilitate still other many-to-many forms such as phone conferencing and video conferencing. Whenever people want to "get together," whether for traditional face-to-face meetings or for some form of **synchronous** teleconferencing (whether by phone, by video, by computer or by some

combination of those), comparing calendars could be much simpler if incorporated into a computer-based interpersonal scheduling system. Comprehensive interpersonal scheduling could also support more continuous interaction through work arrangements, cross consulting, inquiry networking, etc., whenever any degree of synchronizing of schedules may be needed.

Another potential example of many-to-many communication is adaptive referencing or resource referral systems. Computers employing new forms of relational indexing can be used to allow people to weave their way quickly through references and resources until they find just what they need to help solve some particular problem. To the extent that such systems refer such users to "resource **people**," then these systems should be considered to be examples of support for many-to-many communication.

Thus, general teleconferencing, interpersonal scheduling, adaptive referencing and resource referral, to mention just a few, could be considered as further examples of many-to-many communication. However, none of these were shown in Exhibit 1, which already mentions enough unfamiliar concepts that need further development. The next three sections, respectively, focus on developing three subconcepts — inquiry networking, dialogue balloting and interactive graphics -- in order to illustrate this paper's main concept of many-to-many communication.

PART II. TECHNIQUES

3. INQUIRY NETWORKING*

Problem-Solving and Coordination on a Non-Hierachical Basis

When a problem arises in one place, it is often likely that among peers elsewhere the same problems may also be emerging. This may be true among branch offices, among marketing outlets, among research labs, among members of a trade association, among libraries, among government agencies, among legislatures, among neighborhoods, and among other "communities." Through inquiry networking, duplication of effort in problem solving can be considerably reduced. And as a result, much sought after improvements in "productivity" can be achieved.

Basically, this is how inquiry networking works. A short pointed question known as an inquiry is raised by anyone participating. All others then receive this as an "all points bulletin."

Then those who are interested in the topic of this inquiry select it so that they can receive all present and future responses in association with that inquiry. The receipt of such responses by those joining the "inquiry network" is shown in Exhibit 2 as the fourth step within the sequence of six steps that allows many-to-many communication without information overload:

Step 1: Inquirer (I) composes a short, pointed question.

Step 2: Inquirer composes longer background statement (B) as the first "response."

Step 3: All Exchange members receive inquiry, some (J) join the "inquiry network" in order to receive background statements and responses, and a few (R) decide to become respondents.

Step 4: Joiners (J) as well as the original inquirer (I) can receive responses as soon as entered by any respondents (R).

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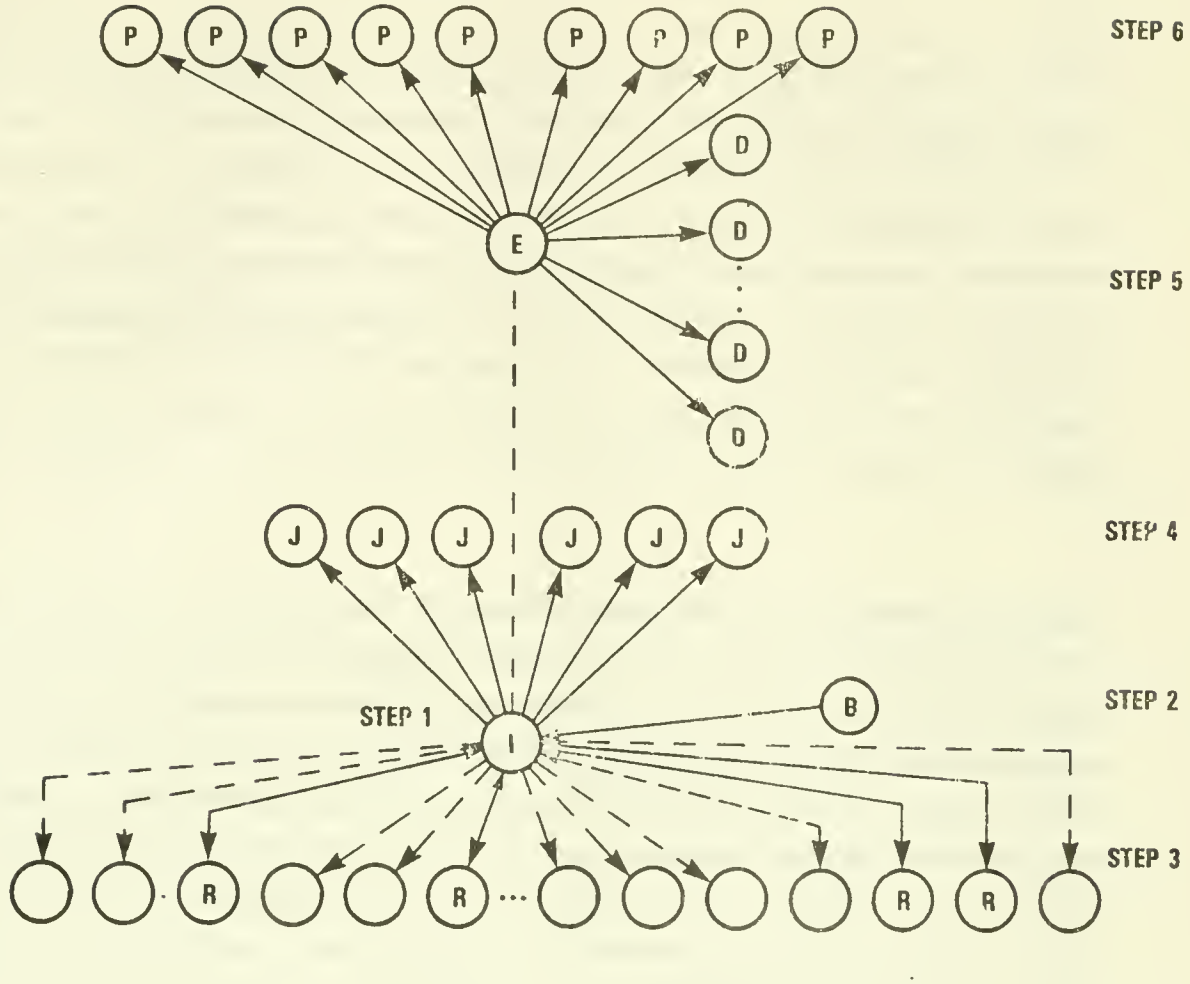
* Much of this section and part of the previous section are revisions of material that appeared in "Many-to-Many Communications through Inquiry Networking" in the **World Future Society Bulletin,** November/December 1980.

EXHIBIT 2

MANY-TO-MANY COMMUNICATION THROUGH INQUIRY NETWORKING



Step 5: Data bases (D) containing inquiries and associated reponses of proven value result as by-products of this communication flow. An inquiry and its associated background and responses are indexed for later retrieval either automatically or with assistance from an editor (E) who may modify inquirer-authored keys but not the principal text of either inquiries or responses.

Step 6: Further offline dissemination of printed briefs (P) consolidating an inquiry and its associated responses is accomplished through interactive newsletters or "netletters" which allow readers again to select topics or join networks of particular interest to them after first seeing a list of recent inquiries. A printed brief (P) may be composed by either an editor or by the original inquirer whose new brief then, in a sense, updates the earlier background piece. Or a more interactive form of printed netletters can be published more frequently or **as required**, in order to allow **print** correspondents to get new inquiries and responses almost as quickly as **online** participants do, in which case no editing of briefs may occur.

Thus inquirers, joiners, data base users and those who order printed briefs all get only the background and responses they want after seeing short inquiries from which to choose. The briefs, background and responses prepared by editors, inquirers and respondents reach wider audiences through inquiry networking than they would through more narrowly aimed mail or phone calls. The best responses can sometimes come from surprising sources, and respondents may put more effort into responding when they know that many more than the original inquirers can benefit from the information they provide.

Inquiry networking can obviously decrease duplication of effort and increase productivity in certain situations. First, there needs to be some **similarity** among the interests of those involved in inquiry networking so that the inquiries, short as they are, will not seem like information overload. Second, there need to be **incentives** — such as peer pressure, funded mandates, and/or profit motives (e.g., answers or consulting for sale) — to encourage responses being made to inquiries. Third, there need to be **standards** among those networking as to what types of inquiries and responses are preferred. Fourth, there need to be **facilitators** to help develop and enforce such standards and, wherever feasible, to modify software to make more obvious the standards as they are developed.

However, most of all, there need to be attitudes that are conducive to information exchange. This means situations are needed where the benefits of increased cooperation outweigh advantages of competing. For example, among branch offices serving non-competing geographical areas, inquiry networking might be advantageous. However if the branch managers all compete for centralized funding or for later career advancement that can be bestowed by headquarters, then such competition-mindedness could interfere with inquiry networking unless strongly mandated by headquarters.

Japan's gains in innovation and productivity might be viewed as being due largely to attitudes there that emphasize group achievements, while in the United States and Canada greater emphasis is put on individual achievement. Inquiry networking can be structured to recognize valuable individual contributions. This can be done by using dialogue balloting to rate responses and by providing payments or credits for highly rated responses to inquiries. However, at the present stage of development, inquiry networking depends more upon less sophisticated incentives such as peer pressure, funded mandates, and advertising advantages associated with responding to inquiries.

Politechs as a Case Example*

An inquiry networking system called "Politechs" enables participants who use EIES (Electronic Information Exhange System) to exchange computer inquiries and responses mostly about public policies. Any member within Politechs can compose inquiries as well as responses in the main Exchange, which is known as Publitech, because it is "open to the public." (The underlying linkage being the citizen's general interests in public policies.)

Other Exchanges within Politechs include Legitech for legislatures, and Localtech for local governments. Publitech is the seedbed, from which other new Exchanges may emerge specializing more in inquiry networking among executive agencies, professional societies, private firms, branch offices, etc.

Approximately a dozen regional innovation groups funded by the National Science Foundation, a dozen state legislatures, a dozen Federal agencies (including the White House and members of the Federal Laboratory

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* C.H. Stevens, "Many-to-Many Communication Through Inquiry Networking," **World Future Society Bulletin**, Vol XIV, No.6, November-December 1980, pp.31-35.

Consortium), and a mixed dozen of technical professional societies, public interest groups, local governments and private firms make up the 50 or so members of Politechs, with occcasional participants from among the approximately 500 other users of EIES.

Any combination of inquirer, respondents, topic selectors or joiners within Politechs represents a spontaneous network which forms around whatever topic is raised in a new inquiry. Then, within any Exchange, an informal group can be designated in order to allow inquiries to be targeted to such a group. Once such a group achieves some critical mass, it may form its own separate Exchange, and the targeting of inquiries to groups becomes less necessary. Through this sequence of forming spontaneous inquiry networks, informal groups, and formal Exchanges, the overall body of Politechs changes and develops.

Exchange facilitators, index editors, and software developers play key roles in supporting the participation of others in Politechs both online and offline. Publications known as **The Networkbook** and **Netnotes** provide outreach to many who are without accesss to Politechs through computer terminals. Some key nodes use smart terminals that already tie EIES into information retrieval services and that will eventually allow many people to have computer access to Politechs without necessarily having to go online to EIES directly.

Just as networks, groups and Exchanges develop almost organically within Politechs on EIES, so also can any particular person's or organization's involvement in Politechs mature from one stage to another. Someone may start by ordering a brief from a newsletter which carries **Netnotes** as an inserted order form (See example of **Netnotes** and associated briefs in Exhibit 3,4, and 5). Later they may participate more directly in Politechs online.

There they will have the opportunity of forming spontaneous inquiry networks, or a new informal group within Publitech or within a more specialized Exchange such as Legitech or Localtech, or one of the specialized informal groups which currently remain within Publitech until they achieve the critical mass needed to form a separate Exchange.

Separate Exchanges within Politechs overlap enough to share resources and participants to whatever extent is desired. Politechs offers new groups the chance to experiment with inquiry networking, computer conferencing and electronic mail on EIES, which can be readily adapted through additional programming to any group's specialized needs. Then, if the group has the potential of growing to a membership of a few hundred or more, a tailored version of this system can be transfered to another computer. Thereafter, distributed interaction with other computers and with EIES as an "electronic laboratory" can be continued if that is desired by any such group.

EXHIBIT 3

Your Politechs

NETNOTES

Issue number 3
November 1980

People are asking . . .

31. ( ) What information is available on the use of Thorium as a fuel in nuclear powerplants?

32. ( ) What existing or proposed legislation do the states have regulating or restricting foreign ownership of land?

33. ( ) What are the requirements for a successful solid waste source seperation and recycling program at the local level?

34. ( ) Has any government agency or legislature taken steps to ban or regulate use of foam insulation or particle board binder that might give off formaldehyde gas?

35. ( ) What are the projected availabilities and costs for different energy vehicles (fuels) for home heating?

36. ( ) To what degree is your state/community involved in developing biomass energy, either from waste materials or from crops grown for tne purpose?

37. ( ) What existing or pending legislation do states have regarding incentives for the use of solar energy?

38. ( ) Does your state provide aid of any sort to communities to undertake their own energy planning -- that is, comprehensive studies of local energy needs, costs, and ways of meeting/reducing future energy demand?

39. ( ) What states have programs to eradicate or limit the spread of bovine brucellosis (also called Bangs Disease), a reproductive disease of cattle?

40. ( ) What information is available on state and local government experiences with compact vehicles?

41. ( ) Is there a standard conversion factor to convert figures on residential solid waste from volume (cubic yards) to weight (tons)?

42. ( ) What products are available to remove graffiti from surfaces, and to make surfaces more graffiti-resistant?

A) Check above for your records. *B) Check below to order.*

31. ( ) THORIUM AS FUEL
32. ( ) FOREIGN OWNERSHIP OF LAND
33. ( ) SOLID WASTE RECYCLING
34. ( ) FORMALDEHYDE REGULATION
35. ( ) HOME HEATING FUELS
36. ( ) BIOMASS ENERGY DEVELOPMENT
37. ( ) SOLAR ENERGY INCENTIVES
38. ( ) LOCAL ENERGY PLANNING
39. ( ) BOVINE BRUCELLOSIS
40. ( ) GOVERNMENT COMPACT CARS
41. ( ) VOLUME-TO-WEIGHT CONVERSION FACTOR FOR SOLID WASTE
42. ( ) GRAFFITI REMOVAL & RESISTANCE

EXHIBIT 4

SAMPLE OF POLITECHS ONLINE BRIEF

PT 91

COMPACT CAR USE BY LOCAL GOVERNMENT

A Politechs Online Brief
from an inquiry by the
New England Innovation Group

INQUIRY:

What information is available on state and local government experiences with compact vehicles? Problems? Benefits?

COLLECTED RESPONSES:

The Maplewood, MN police department used Saab automobiles as squad cars for awhile, but has now abandoned them. Apparently the officers felt that the cars were too small for them to carry out police business. The department's phone number is 612/777-8131.

Willingboro, NJ replaced full-size sedans with compact cars for police officers. Contact the Town Manager at 609/877-2200.

Kettering, OH has compacts in its fleet; the problems encountered have been mostly "people problems." The main administrative fleet consists of retired police vehicles, it having been found economically feasible to use these vehicles rather than trade them in. As price and availability of fuel become more serious problems, life-cycle costing will dictate the use of compact vehicles. In 1979, Kettering was experiencing costs of 14.0 cents per mile to operate Dodge Aspines with police package and no maintenance costs included. Older Novas were costing 14.3 cents per mile with maintenance.

Kettering maintains fleet operating records on computer, and has indicated it can provide such data for all compacts and other cars in its fleet.

Milwaukie, OR is purchasing used subcompacts for administrative transportation. Contact the City Manager at 503/659-5171.

Garden Grove, CA has an on-going evaluation of the use of compact police vehicles versus full-size.

The Southwest Innovation Group has produced a comprehensive report on use of compact cars as police vehicles, analyzing life-cycle costs. There mailing address is 181 S. Los Robles Ave., Pasadena, CA 91101.

And for free literature on compact cars used as police vehicles, contact U.S. Department of Justice, LEAA, Box 6000, Rockville, MD 20850 (202/862-2919).

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International City Management Assn., 1140 Connecticut Ave. NW, Washington, DC 20036

City of Kettering, Attn: Mr. William VanTrease, Technology Agent, 3600 Shroyer Rd., Kettering, OH 45429

Mr. John Niles, Control Data Corporation LOGIN Project, 2430 Otis Street NE, Washington, DC 20018

EXHIBIT 5

SAMPLE OF LEGITECH BRIEF ON PARTICIPANT'S LETTERHEAD

Science Resource Office
Massachusetts General Court
State House - Boston 02133

N-6/78#3
MA-7/77

Road Salt

INQUIRY: How can the health and environmental effects of spreading salt on icy roads be reduced?

BACKGROUND: During the winter, the Massachusetts Department of Public Works (DPW) spreads salt (sodium chloride) on roads to prevent snow from freezing into ice. As sand is applied to icy roads to prevent people from slipping and cars from skidding, salt is further used to prevent this sand from freezing. Salt spread on roads and improperly stored salt can eventually seep into ground water supplies and enter drinking water. The increase of sodium levels in drinking water can create health problems, including hypertension and heart disease. High chlorine levels can also be unhealthy. Salt further damages and destroys roadside vegetation, and causes corrosion in vehicles, road structures, and bridges. In 1973, the Massachusetts Legislature enacted a law regulating the spreading and storage of road salt (Massachusetts General Laws, Chapter 85, Section 7A).

RESPONSE: There are two classes of methods for reducing the dangers of road salt:

A. Less hazardous use of road salt.

1. Reduce the amount of salt and number of applications. The maintenance of bare pavement may not always be necessary for safety. Standards for applying salt can vary according to weather conditions, road types and average daily traffic.

2. Install synchrometers on trucks to regulate the flow of salt, make spreading uniform, and prevent salt build-up when trucks slow down. This can be accomplished by synchronizing the speed of the salt conveyor with the speed of the truck.

3. Improve salt storage by using enclosed waterproof sheds with asphalt floors.

4. Improve salt drainage from roads. Divert the salt from reservoirs and other critical areas.

5. Desalinate contaminated drinking water. Salt can be eliminated from water by boiling it in the process of purification for drinking. This plan is still in the experimental stages, and must be made economically feasible before it can be implemented. Moreover, it would not solve the general environmental problem posed by road salt.

B. Substitutes and supplements for the use of road salt.

1. Reduce the speed laws on icy roads to prevent skidding.

2. Use tirechains on vehicles traveling on icy roads.

3. Use various substitute materials such as calcium chloride, urea, and UCAR (a chemical produced by Union Carbide). These substitutes, however are generally less available, more expensive, and less effective than sodium chloride in melting ice and snow. They may also have their own health and environmental hazards. Abrasives such as sand and granite can provide traction for vehicles, but cannot melt ice and snow. They also tend to blow away.

4. Pipe up heat from beneath roads to prevent them from freezing. This experimental method must also become economically feasible before it can be implemented.

KEY RESOURCES:

(617) 727-4706
Frank Carr
Mass. Dept. of Public Works
100 Nashua Street, Room 514
Boston, Massachusetts 02114

(617) 259-9500
Dick Henry
Mass. Audubon Society
South Great Road
Lincoln, MA 01773

REFERENCES:

Terry, Robert C., Jr., "Road Salt, Drinking Water and Safety" Cambridge, MA Ballinger Publishing Co, 1974

4. DIALOGUE BALLOTING

Polling not to Elect nor to Sample but to Facilitate Participation

In Exhibit 1 on the textural to quantitative spectrum of computer usage, we represented dialogue balloting as being more quantitative or more structured than inquiry networking, which in turn was represented as being more quantitative or more structured than computer conferencing and electronic mail.

In moving from communication of textural or fuzzy* information to quantitative or well-defined information, many more people can become involved, because the shared basis for such communication becomes more precise. For example, in moving from unstructured electronic mail to computer conferencing, it is the theme or shared purpose of any computer conference that makes conferencing among many effective. And, in moving from computer conferencing to inquiry networking, many-to-many communication is facilitated further by the pointed nature of inquiries, which are therefore more worth saving along with associated responses for later retrieval from a structured data base. Now, in this section we will see why dialogue balloting, with its better bounded alternatives, can provide many-to-one feedback for traditional forms of one-to-many presentations while facilitating more instantaneous forms of many-to-many communication.

Dialogue balloting can be used to give any speech or presentation a more interactive quality. The audience (those usually expected to receive a presentation passively) can get "into the act" on a continuous basis if they are equipped with small response terminals of the sort shown in Exhibit 6.

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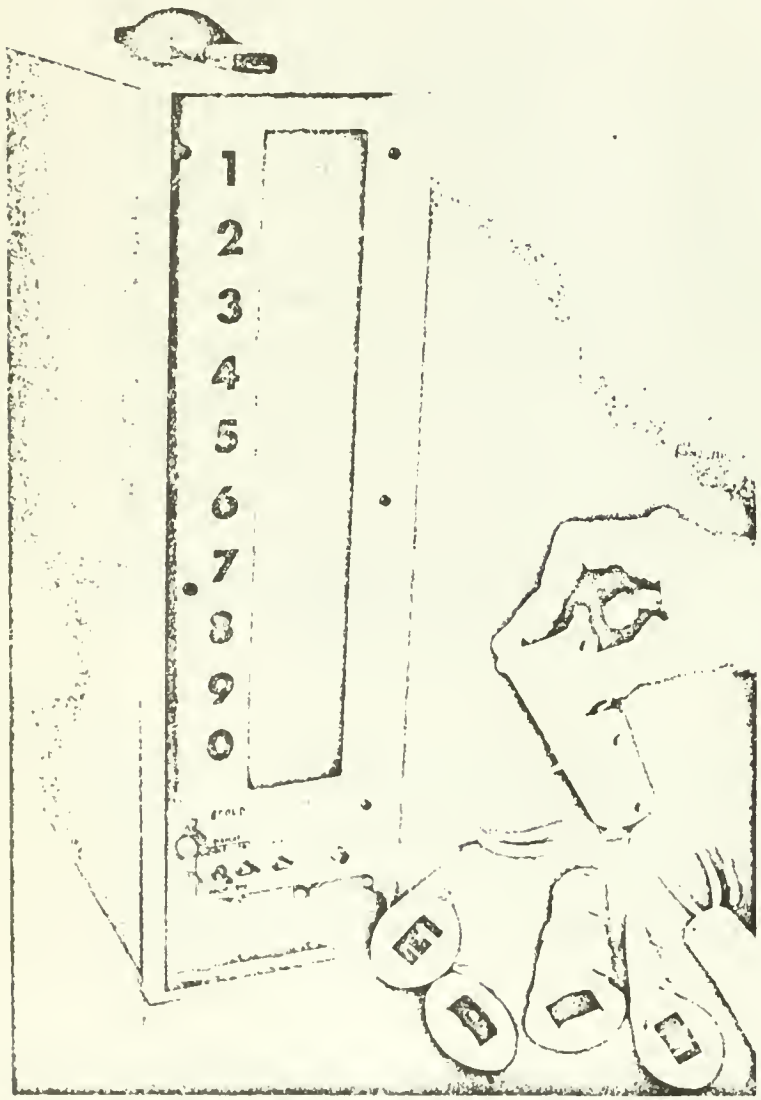
* What mathematicians call "fuzzy set theory" can be used to show how words and phrases only probabilistically rather than precisely include the real phenomena they are intended to describe. Such probabilities are subjective in that they vary in the minds of persons using textual language to communicate.

EXHIBIT 6

EXERPT FROM FLIER FOR DIALOGUE BALLOTING SYSTEM

group/dialog system – 5



provides anonymous, instantaneous electronic feedback to help your group meeting get farther faster with 100% participation

compact, easy to use, reliable and rugged it's been customer proven!

accommodates any number of response terminals up to 99, with full accuracy

optional microprocessor provides percentages and weighted averages in addition to direct vote

flat-faced numerical displays bright in normal room light easily readable from 50 feet away and over a wide angle of viewing indicate total number of votes in each of 10 response categories

vote actuation remotely or automatically every few seconds if desired

any one of last 7 complete tallies can be recalled and displayed

can be set up in any room setting in only a few minutes

attractive carrying case holds entire system, fits under normal airplane seat

purchaser provided with instruction on various techniques to improve group dialog and decisions

prices available upon request

also available, group/dialog system-8 for up to 512 participants with larger display visible 100 feet away and with additional options such as automatic prioritizing

During the course of an interactive presentation, each participant can continuously adjust the setting of his or her 10-position response dial (similar to the dials on airlines used by passengers to select music channels on individual headsets). The presentor could suggest to the participants one of various possible codings of the 10 dial positions. The participants could even use the system, before the presentation begins, to vote on what coding of the response settings they as a group might prefer. Here is an example of one protocol that has been used to provide many-to-one feedback in response to a one-to-many presentation:

0. Idle (terminal is not in use)
1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly disagree
6. Don't understand - Explain
7. Too fast - Slow down
8. Bored - Speed up
9. Please conclude soon

If the display panel (Exhibit 6) is positioned so that only the presentor can see it, then this use of dialogue balloting typifies many-to-one, rather than many-to-many communication. However, if all respondents can see the continuously changing tallies of this group feedback on a main display panel, then use of dialogue balloting becomes at least a primitive example of many-to-many communication.

Two other dialogue balloting protocols more explicitly designed to support many-to-many communication are the structured question protocol and the discussion tree protocol. Dialogue balloting involving structured questions on the subject to be discussed can stimulate discussion either in a small group (as few as five) or in a large group (as many as 500). Since balloting here is meant to help structure follow-up dialogue involving more familiar forms of verbal exchange, the multiple choice questions should be thought-provoking. In addition, among the alternatives posed should be choices designed to provide

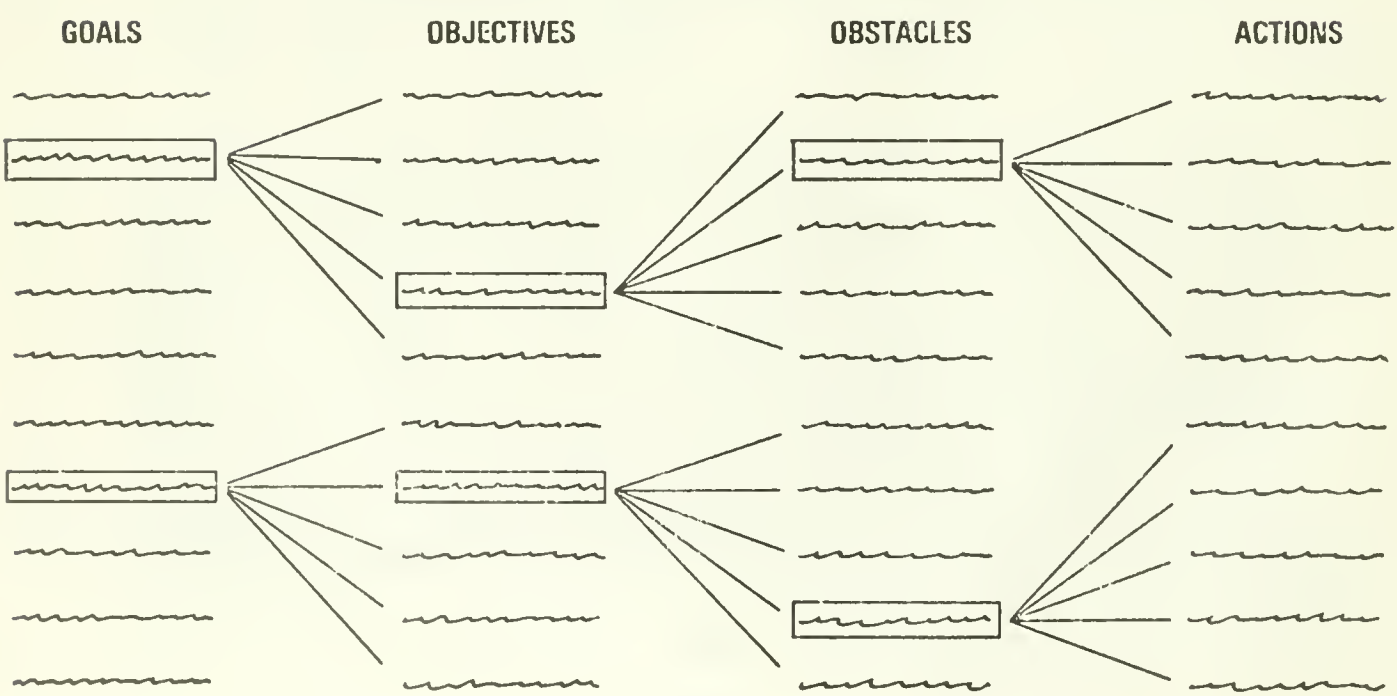
feedback about the wording of the question, exemplified by alternatives 5, 6, and 7 below:

"What do you think...(etc.)...?
1.)
2.} (Well-structured range of thought provoking
3.) options about the subject to be discussed)
4.)
5. Other (open-ended alternative)
6. Object (... to the wording or content of question)
7. Don't understand (...well enough to respond)

Dialogue balloting involving structured questions can easily be confused either with voting to achieve consensus or with opinion polling. A major difference is that dialogue balloting, unlike either consensus voting or opinion polling, uses questions to stimulate thought and dialogue (the Socratic method). The only consensus that is generally sought through dialogue balloting is the group's choice of subject matter. This can be illustrated by the discussion tree protocol for dialogue balloting as shown in Exhibit 7.

EXHIBIT 7

DISCUSSION TREE, FROM GENERAL TO SPECIFIC
BUILT OUT OF PRIORITIZED IDEAS
OBTAINED FROM GROUP BRAINSTORMING



The wavy lines in Exhibit 7 indicate short phrases which, when posted on large sheets of paper, can be saved as a record of the group's memory. The recorder or editor who does the posting does not have enough space or time to record exactly what a group member says when brainstorming. Thus, the short phrases posted serve as "memory hooks" to help those who heard the complete ideas remember enough to be able to prioritize those ideas as a basis for further discussion. The specially designed microcomputer which is the core of the portable dialogue balloting system, shown in Exhibit 6, is used for prioritizing in face-to-face meetings or conferences.

As computer networking becomes increasingly widespread during this decade, dialogue balloting should also become widely used among dispersed participants in electronic meetings rather than always involving face-to-face communications. Ultimately, two-way home video sets can be expected to make frequent use of dialogue balloting.

Interactive Media as a Case Example*

A wide variety of settings can be developed for dialogue balloting to support many-to-many communication. For example, in the early seventies, experiments were conducted to determine to what degree one-to-many forms of **mass** media might eventually be transformed into **interactive** media as new means of support for many-to-many communication.

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* C.H.Stevens, "Media-Based Issue Balloting" in **Citizen Participation Certification for Community Development**, edited by Patricia Marshall and published by the National Association of Housing and Redevelopment Officials, Washington D.C., 1977

A series of dialogue balloting exercises were conducted using different types of mass media sometimes in coordination with each other. For example, in 1972, a series of three interactive television shows were coordinated with dialogue balloting through newspapers. Phone feedback was also used to involve the home viewing audience, and studio participants used a forerunner of the system shown in Exhibit 6.

Show 1 featured a panel of educational experts explaining to studio participants and phone respondents structured questions posed both through televised dramatizations and through a "feedback ballot" published that day in area newspapers.

Show 2 in the three-part weekly television series brought into the studio three groups of phone and newspaper respondents — (1) students, (2) teachers and (3) school parents and others not having children in school. The three most important among the ten original questions — as judged by previous phone and newspaper balloting — were then discussed. Dialogue balloting was used to stimulate discussion separately within each of these three peer groups. Video tapes of the separate discussions were subsequently intermixed to show how students alone, then teachers alone and, finally, others alone felt about each of those three selected issues.

For Show 3, a mixture of 30 students, teachers, and others (including one school administrator) were brought together from one community. This group, which surfaced because of interest in Shows 1 and 2, used the discussion tree protocol to discuss what action might be implied by the goals that they favored most.

Following that experiment in interactive television, studio dialogue balloting and interactive features in newspapers, similar formats were again used not only for education but also for transportation and energy

planning purposes. We were careful, in all forms of interactive media, to place the emphasis on stimulating and facilitating dialogue rather than on achieving consensus as in elections or measuring opinion as in scientific sampling. For purposes of dialogue balloting then, the following types of questions were used in several newspaper experiments:

Background questions, which might indicate the respondent's geographical location, age bracket, level of formal schooling, and other pertinent information.

Feedback questions, each of which usually consist of four structured alternatives plus a fifth open ended option that can be specified by the respondent. The format shown in Exhibit 8 allows for up to ten such feedback questions, not too many to inhibit respondents but enough to stimulate them to think about less obvious aspects of a subject, as illustrated especially in feedback questions 6, 7, and 8 in Exhibits 9 and 10.

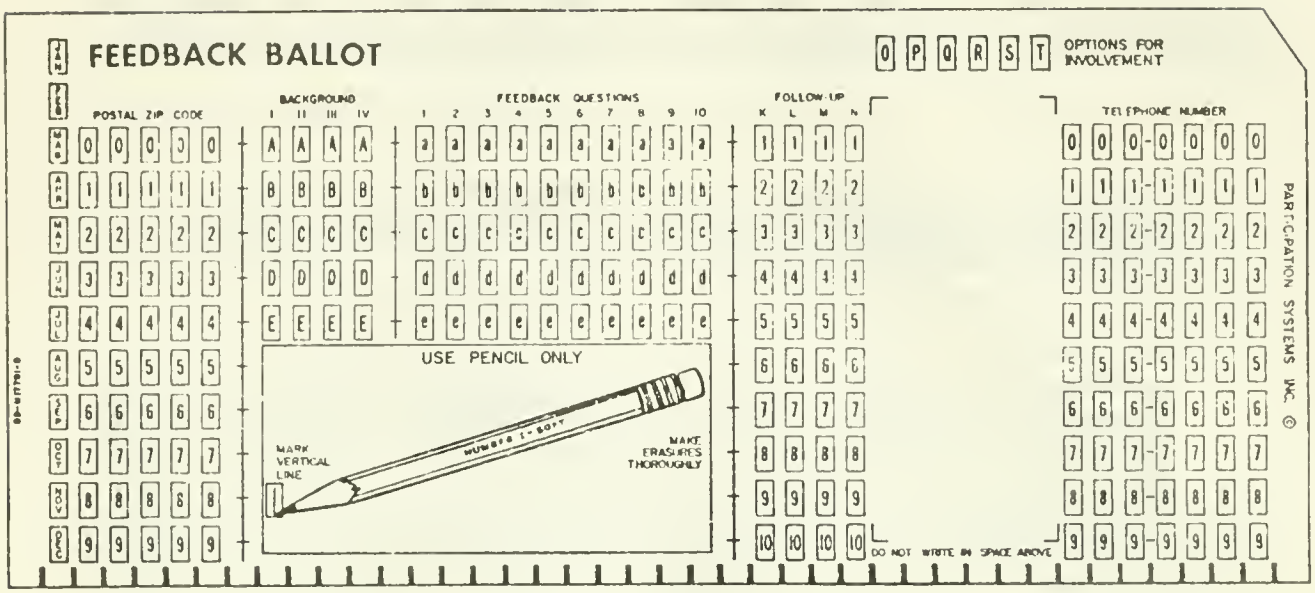
Follow-up questions, not unlike standard options at the end of structured questions used in dialogue balloting, allow respondents to critique feedback questions by rating which (usually up to three) they felt were most important, most biased or unfairly worded, most unclear or in need of additional information, and most suggestive of personal actions they may want to take. The format in Exhibit 8 indicates how four such follow-up questions can be used to rate the ten previous feedback questions.

Options for involvement may be included. In the case featured in Exhibits 9 and 10 these options were given respondents:

0. Discuss these issues on a face-to-face basis with other concerned citizens.
P. Probe some issues more deeply through a formal study program.
Q. Join a temporary alliance to take specific follow-up action.
R. Help organize a group for follow-up discussion, learning, or action.
S. Help develop questions for another feedback ballot.
T. Help develop community nodes to support continuing feedback balloting and involvement networking.

EXHIBIT 8

FEEDBACK BALLOT FORMAT FOR OPTICAL READING AS COMPUTER INPUT



Feedback questions 9 and 10, as indicated in Exhibits 9 and 10, helped determine which types of consumer actions and political actions the ballot respondents favored taking themselves. They were also given the option of remaining anonymous at the end of the ballot. If they chose to identify themselves, they had the further option of designating any public official or other persons to whom they wanted to have forwarded their opinions and/or comments. The newspaper, in forwarding such comments to a designated official, encouraged that official to respond back to the ballot respondent by means of an open letter for publication in the newspaper. By that means, one-to-one dialogues by letters could become a part of the newspaper's larger many-to-many dialogue, as a variation on the more traditional practice of publishing letters-to-the-editor. For example, the newspaper involved in this case published a letter it recieved from President Ford. The President wrote in response to letters that were designated by certain ballot respondents to be forwarded to him.

EXHIBIT 9

SAMPLE RESULTS OF FEEDBACK BALLOTING ABOUT THE ENERGY CRISIS

Two weeks ago, The Sunday Record printed the questions in this box as a way for readers to express their opinions on the energy crisis. The figures to the left of each choice represent the percentage of people who selected that choice.

1. President Ford has called on all citizens to become "inflation fighters and energy savers." What do you think you can do to help solve the energy crisis?

20% a Prepare, as President Ford suggests, a list of 10 ways you will save energy and fight inflation, show the list to a neighbor, and send it to the White House (possibly through the space provided on this ballot)

43% b Concentrate less on personal actions and more on influencing political and economic policies through the forthcoming elections, etc

11% c Although I personally am concerned I don't think anything I can do will make much difference

1% d I don't think the energy crisis is a critical enough issue for me to complete this ballot

25% e Other

2. Which of the following seems to be most responsible for the energy crisis?

9% a Government energy planners and shortsighted politicians

14% b Big oil companies who are profiting from a crisis they helped create

9% c The oil producing nations which are taking advantage of the world situation to raise their prices

46% d The consumer mentality in this country — excessive advertising, unlimited consumption and wasteful production

22% e Other

3. In your opinion, which of these domestic goveromental policies would contribute most toward a solution?

41% a "Project Independence" — research and exploration to develop more energy, to use it better, and to make the U.S. more self sufficient

10% b The government should step in with strong measures such as rationing and price controls or the creation of public energy corporations

14% c The government should offer incentives for energy conservation by imposing a gasoline tax or by other taxes and subsidies to reward recycling of products, etc.

10% d The government should get out of the market — relax environmental standards and allow supply and demand to set supplies and prices moderated only by voluntary restraints

22% e Other

4. Which of these foreign policies should our goveromont adopt to deal with the energy crisis?

1% a If necessary, take military action to force the oil producing nations to supply us at reasonable prices

FEEDBACK

42% b Apply economic sanctions in cooperation with other countries — for instance, withhold food, restrict sales and credits or cut off foreign aid

6% c Put pressure on Israel to settle its conflict with the Arab nations and settle the Palestinian refuge question as part of our negotiations with the Arabs to hold down oil prices

33% d Recognize that the traditional power politics won't work and concentrate more on domestic policies

18% e Other

5. Which public transportation policy do you favor most?

16% a Increase public subsidy of rapid transit and new forms of personalized busing such as dial-a-bus

10% b Increase research and development of new systems such as mono-rail and magnetic levitation

48% c Development of better management of existing transportation systems such as railroads and subsidize most efficient in terms of energy consumption, freedom from pollution, etc

9% d Substitution of communication for transportation through development of capabilities for shopping by phone and computer etc

17% e Other

6. Which form of car sharing would you most likely favor?

40% a Further develop and encourage widescale use of computerized matching systems to facilitate car pooling

12% b Encourage hitch-hiking by making it safe and legal (e.g. develop personal identification system similar to credit cards)

18% c Make cars public property so that anyone could drive any car available at a public car stand, pay a small fee and leave the car at another public car stand near his destination

22% d None of the above. Retain the present pattern of private use of the automobile

8% e Other

7. Which of the following working conditions or arrangements would you favor for development in the future?

27% a Work fewer days per week but longer hours per day to reduce commuting

15% b Encourage "home-based industry," self-employment, independent contracting, etc

30% c Flexible scheduling to reduce congestion at peak hours

14% d Greater use of improved communications—telephone, cablevision and computers to link local workers with central offices

14% e Other

8. Which overall urban planning approach do you favor most?

13% a Encourage development of more self-sufficient new towns of 50,000 to 250,000 people

29% b Reorganize within large existing metropolitan complexes so that access to jobs, commerce and recreation by public transportation is available to all

34% c Development of goals for urban growth by truly representative citizen imput and consensus instead of being developed by central bureaucracies, developers and business

14% d Urban concentration is caused by people living where they prefer to live and planners should not interfere with people's freedom to live and work where they please

10% e Other

9. Which of these consumer actions might you most likely take?

29% a Use a bicycle or otherwise develop a low energy-consuming lifestyle

25% b Economic boycott of energy-wasteful products and institutions

12% c Investigate using a windmill to generate your own electricity or solar rooftop collectors, waste converters, etc

22% d Participate in community information sharing on products and institutions, and monitor effectiveness and impartiality of state and national regulatory agencies, consumer councils, etc

12% e Other

10. Which of these political actions might you most likely take?

25% a Run for office or support candidates for elective office who are calling for new values and priorities

18% b Support local and national environmental and alternative lifestyle groups

31% c Work for reform in energy rate-structures to promote fairness for small consumers and to encourage conservation of energy

16% d Petition government officials and Congress for stronger anti-trust laws and strict enforcement (e.g. to prohibit auto manufacturers from controling public transportation systems

10% e Other

EXHIBIT 10

SAMPLE BEGINNINGS OF NEWSPAPER DIALOGUE
STIMULATED BY FEEDBACK BALLOTING

As reported in Troy, New York's The Sunday Record, October 20, 1974

Here's What YOU Said About The Energy Crisis

"The key issue to me in the energy crisis is one of understanding — who is responsible and what alternatives we really have... We have to begin to re-order our values and priorities. We can no longer buy our high standard of living at the expense of other people in the world community..."

Like John Holehan, the Troy resident who sent in that comment, people who took the trouble to fill out the energy crisis FeedBack Ballot which appeared in The Sunday Record Oct. 6 see more questions than solutions.

Judging from these responses, people are most interested in the causes of the energy crisis, and most interested in finding solutions in the realm of public policy. And while the "consumer mentality" is seen as the primary cause of the crisis, the people who responded tend to concentrate less on personal economies and more on influencing economic and political policies.

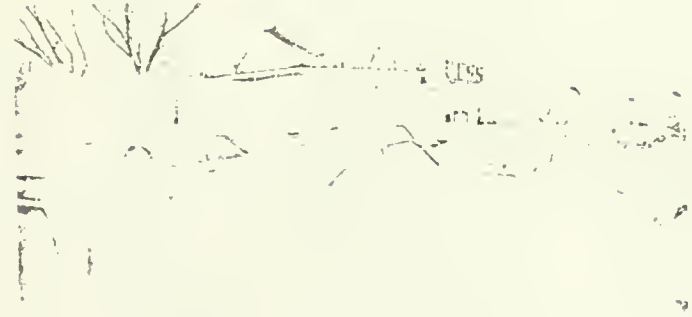
FeedBack Balloting is not a public opinion poll, and does not pretend to be a scientific sampling of the population. The 123 people who filled out the energy crisis ballot (two-thirds of them readers of The Sunday Record) show an obvious interest in this very complex issue.

They selected themselves, so to speak.

As a group, the people who responded have at least one car and showed very little dependence on public transportation. They are a well-educated group — 84 per cent had gone beyond high school — and their ages range rather evenly from 18 to over 65.

An involvement newsletter called CHIMO, which is sent all over the world, brought 47 responses to questions 5 through 10 and the follow-up questions. Seven of these responses came from Canada, one from Latin America, and one from Japan. The other 38 were scattered throughout the United States to compliment the 76 responses from the Troy area.

One of the goals of FeedBack Balloting is to allow people to follow through with the kind of action that most suits them. The high proportion of people who chose a Follow Thru Option on this ballot shows that many people do think there is a need for more citizen involvement.



Forty-two people said they would like to discuss the issues with other people, and another 25 would be interested in a formal study program to probe the issues more deeply. Twenty-six people are interested in joining a temporary alliance for specific action, while 14 people would like to form such a group.

If you want to get in touch with people whose interests match yours, you may use the resource list of interested persons filed at The Record.

We received numerous suggestions for future FeedBack Ballots, from the problems of youth to handicapped persons, drugs and advertising. Twenty-six persons want to write a ballot themselves, and 32 people support continuing FeedBack Balloting and Follow Thru involvement. (In addition to the FeedBack Ballot on morality and politics which ran Oct. 13 in The Sunday Record, a ballot on local urban problems is planned for next Sunday.)

How do your opinions relate to others? For a percentage breakdown of the results, see the box above. Here is a brief discussion of each question, as it was seen by the people who responded.

1. While most people emphasized public policy making, a few submitted their own ideas — eliminate unnecessary stop lights, "conformity to [illegible] of nature", developing a "conservation ethic". This question was seen as not terribly important, and placed third on the list of questions which people thought were biased or unfairly worded.

2. Almost half of the people responding to this question chose to place the blame very close to home. And older people especially favored that choice. This issue of responsibility was voted second in importance, but a large number of people thought the question was biased or unfairly worded.

3. Here the emphasis is clearly on self-sufficiency. Project Independence gets top priority, and we received numerous suggestions such as a massive advertising campaign "to lower desire level" and improving business morals. The percentage of people favoring self-sufficiency increased with age level, but this choice was less favored as education level increased. This question ranked number one in importance, but some people found it not clear.

4. Again, the two choices most favored — ecoooomic sanctions and more concentration on domestic policies — appear to relate back to self-sufficiency. "Use our own resources, help our people before others," said a Troy resident. Foreign policy was named the fourth most important issue on the ballot.

5. Public transportation is also an important issue, ranking third. While the option to improve existing transportation systems (the least extreme choice) is clearly the most popular, there are some interesting relationships. As age increases, so does the percentage favoring this choice. And the percentage of people favoring this solution decreases as the number of cars they own decreases.

6. Curiously, while public transportation was ranked as a highly important issue, this question on car sharing was ranked lowest in importance. It is also interesting that car sharing is not ranked high as suggestive of personal action. "Encourage car pools by public statements and by preference in parking, bridges, tolls etc.," said A.D. Randall of Sand Lake in support of the most popular choice.

7. Every age group but one — the 25 to 49 year group — chose flexible scheduling of working hours as the best way to improve working conditions. The 35 to 49 year group, our primary work force, emphasize fewer days and longer hours. This question was often selected as unclear, along with other questions which dealt with changes in lifestyle.

8. The younger and older ends of the age scale, those under 34 and over 65, tend to favor citizen participation in goal setting, while the middle group, 35 to 64, lean toward reorganizing cities. Almost 50 per cent of the people with graduate or professional degrees favor reorganizing cities also. This question was voted most unclear and ranked third as being biased or unfair.

9. Consumer action tops the personal action list. The bicycle option gets a heavy vote from the young, with a dramatic decrease in popularity as age increases. On the other hand, economic boycotts are most favored by those 35 to 49, and people over 50 tend to favor community information sharing.

10. Political action ranks high as a step the people who responded to this ballot might take. Of the people who would be most interested in working for rate reforms and fairness for consumers, the highest representation came from the 50 to 64 age bracket and those with a college degree. Direct political action is very evenly spread among all age and education levels.

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5. INTERACTIVE GRAPHICS

A Language to Interpret Many-to-Many Communication

Interactive computer graphics is already recognized as an important part of decision support systems, which focuses on **individuals.** Now, through consideration of interactive computer graphics, we will see how many-to-many communication can extend decision support systems to include **groups** as well as individuals.

Computer graphics become interactive in nature when the person or persons viewing them can make on-the-spot adjustments. Selection of what data is to be shown in the first place, as well as specification of graphic parameters to be used in the computer display, might be done on an interactive basis, whether through a key board, light pen, touch sensitive panel, voice-actuated circuits, etc. However, interactive **selection of data** for display is not all we mean to imply by the phrase "interactive graphics." Manipulation of data on display screens and in computers backing up such displays can also be done on an interactive basis. A flexible interactive graphics capability is a valuable aid to decision-making and, even more, an aid to group dialogue which leads to individual decision-making.

Interactive graphics, as we will see, can be considered as a technique of many-to-many communication in its own right. First, however, we should consider how interactive graphics can enhance the other techniques of many-to-many communication already discussed here — namely inquiry networking and dialogue balloting.

Interactive Graphics and Inquiry Networking

Graphic display of trends in inquiries or in other pointed communications such as complaints (negative inquiries) or suggestions (positive inquiries) can serve as early warnings for high-level

policy-makers to take action, even when they have not had sufficient time to absorb the full content of such inquiries, complaints, and suggestions. Lower-level operations personnel in an organization may be assigned responsiblity for responding in detail to such communications as inquiries, complaints and suggestions from clients or consumers, and from employees or workers. However, case-by-case handling of such inquiries often overlooks the fact that a whole class or category of people may be better satisfied if high-level policies are changed. For example, a citizen feedback system might use interactive graphics to show a governor and his cabinet where complaints are arising most with respect to geographical locations and/or program areas. They may then decide to focus more attention on a certain issue before an emerging problem becomes a crisis. Or, unmet consumer needs might be detected by graphic analysis of inquiries in order to indicate to a corporation's board of directors where they should allocate market research funds. Similarly, employee feedback, particularly in large firms, could be distilled graphically for top management, who otherwise might not detect emerging opportunities for innovation and/or improved productivity as expressed in employee suggestions.

Interactive Graphics and Dialogue Balloting

The applicability of interactive graphics in support of many-to-many communication is even more obvious with respect to dialogue balloting than with inquiry networking. The numeric display panel shown in Exhibit 6 for one particular dialogue balloting system has, over the past ten years, been augmented occasionally by computer graphics in order to show more readily how balloting responses might be distributed over the population or respondents, over the range of options considered, and/or over time, if sequential balloting occurs. New technology such as computer networking, large-screen video projectors, and increased variety in interactive terminals, as well as recent advances in graphics technology together make interactive graphics more available than ever before.

Interactive Graphic Possibilities

To illustrate the possiblitlies of interactive graphics (outside of inquiry networking and dialogue balloting), we could examine an experiment that originated in the sixties. However, in order to update what was done then to take better advantage of improvements in computer graphics and related technologies, what follows is better characterized as a "case scenario" rather than as an actual case example. The following scenario is an extension of what was done in 1967 at MIT to demonstrate how interactive computer graphics could be used to support group dialogue about drawing election districts. This scenario includes extensions which, though envisioned then could be much more readily accomplished now because of advances made in various technologies.

Geodata as a Case Scenario*

In the early sixties, I worked on one of the early computer designs for an electronic drafting machine. Some of the techniques developed then were later in 1967 applied to drawing congressional districts, using a system which came to be known as Geodata. During the Geodata experiment, a judge, an aide to a U.S. Congressman, a state legislative aide working for a congressional districting committee, a newspaper reporter, League of Women Voters members, and various others could be found huddling around a single graphics terminal designed for a single user. On the screen was drawn a map of Massachusetts divided into 12

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*C.H. Stevens, "On The Screen: Computer Aided Districting," **Conflicts Among Possible Criteria for Rational Districting**, National Municipal League, New York 1969.

congressional districts. Underneath the map was a table of statistics made up of one row corresponding to each of the 12 districts, with columns displaying:

- population of each district;
- percent deviation from the average population, as a test of how well each district met the U.S. Supreme Court's one-person-one-vote criterium;
- a contiguity check to indicate whether **all** parts of each district were contiguous to at least one other part;
- a "Gerry index" -- the sum of the squares of the distance of each population unit from that district's center of population, weighted by the population of each unit — as a measure of district spread, to help determine how well any districting plan met the courts' criterium that districts be compact rather than be "Gerrymandered" (named in "honor" of Massachusetts' former Governor Gerry) to favor certain political forces; and
- separate columns showing numbers of Democrats, Republicans and Independents (i.e., registered voters not enrolled in either of the two major parties) there were in each district.

On one occasion, I sat at the terminal keyboard and moved towns among districts, in accordance with a change being considered by a legislative committee. In addition to statistics being printed offline for comparison, the table on the screen also showed plus and minus signs after any statistic that changed, in order to quickly indicate the direction of such changes. In this case, it was easy to see from the last three columns showing party enrollments that the change being considered would favor a particular incumbent congressman without making the districts become less equal in population, but causing the overall Gerry index to rise, showing the revised districts to be less compact.

Then, to illustrate how compactness could be improved without sacrificing population equality, I used the keyboard to initiate an iterative program that displayed increasingly compact districts being redrawn around the population centers of the previous districts shown on

the screen. The computer algorithm used was a "model" using linear programming to reassign indivisable population units (towns, Boston wards, and other cities) to district population centers so as to minimize the sum of the Gerry indexes for the twelve districts. There were two constraints: population units of any district had to be contiguous and all districts had to be as nearly equal in population as possible without dividing any of the basic population units.

In election districting, there are actually many more criteria that are taken into account besides district equality of population, contiguity, compactness and various types of Gerrymandering in favor of incumbents, parties, particular minorities, etc. Various indicators of a "sense of community" are often considered, such as patterns found in commuting, newspaper reading, phoning, shopping, schooling, etc. Also physical barriers such as rivers, superhighways and mountains may be important.

Here then is a scenario for how group dialogue could be aided by interactive graphics not only for election districting but in various similar situations that could involve some degree of computer modeling. Consider an ever changing spectrum of data:

- some in the minds of participants;
- some available in such visual forms as color-coded maps;
- some quantified in computer memory and available to be displayed in tables or graphs;
- some imbedded in more complex computer models that might be called upon to show less obvious consequences or projected impacts that alternative preferences and/or alternative assessments of facts might imply.

Consider, as another example, how two-way cablevision could be used to allow home viewers to indicate preferences with regards to where a new

shopping center might be located. Although a planner's model of economic and social relationships could help assess projected impacts, so could the estimation of both preferences and probabilites by home viewers.

The spectrum from mental judgments to computer models is best viewed as being not only continuous but also dynamic, in that when any causal mechanisms and decision-making functions become well enough understood to be incorporated into computer models, then the participants who accept those models as being valid enough to be helpful can then apply their judgmental powers to less well understood aspects of the same issue or other issues.

Returning to the Geodata districting example, as varous districting criteria become better understood they might also be modeled rather than merely be considered by looking at color-coded overlays showing various potential indicators of "community patterns." If, then, someone attempts to combine these into a single "objective function," the subjective weights to be applied to competing criteria could be estimated by some form of dialogue balloting among many participants. This use of interactive graphics and dialogue balloting would not substitute for verbal dialogue, which, of course, would be needed even to suggest revision in any such computer modeling.

Thus, both preferences and expectations could be expressed by many persons and interpreted with the aid of mathematical models and computer graphics for those same people and/or others to see -- sometimes instantaneously, sometimes in face-to-face meetings, sometimes asynchronously to allow for more participation at varying times, and sometimes among widely dispersed participants communicating through rapidly proliferating computer networks.

Face-to-face meeetings of various sorts could become peak events within a continuum rather than isolated events, because the meeting participants would be working with the same interactive graphics before the meeting began and, again, after the meeting was over. Interactive graphics on large screens available in face-to-face settings would be similar to the interactive graphics used on a more dispersed basis through smaller individual terminals.

Interactive graphics terminals for teleconferencing could become as common as phones or television sets. In fact, institutional barriers now taken for granted could be readily penetrated. Imagine, for example, how interactive graphics projected onto a large screen in the corporate board room of the future could be readily tied into interactive television sets in the homes of employees or consumers who may be mutually interested in decisions to be made by the corporation(s) or other organization(s) involved. That vision of that not-too-distant future will seem promising to some and threatening to others. The hardware and software needed to support many-to-many communication through interactive graphics can readily be developed. What research is most needed now concerns people themselves: their mindsets, feelings, roles, organizational arrangements and societal institutions, as they develop and use many-to-many communication.

III. PROJECTIONS

6. THE TRANSFORMATION

New Support for Executives, Professionals & Prosumers (Producers-Consumers)

In Part II we examined three specific techniques of many-to-many communication. Now, in Part III we will examine more general societal projections that may influence and be influenced by the development of many-to-many communication.

The first projection is that organizations will change substantially and, in fact, society as a whole will undergo a transformation. As background for understanding this projection, we need to consider the meta-rule* which has thus far guided the course of civilization. In brief, this meta-rule favors **articulated or shared** knowledge over larger reservoirs of **rational or reasoned** knowledge, which in turn are favored over still larger reservoirs of **intuitive** knowledge in the development of tools and technologies.

These segments of knowledge in human minds are depicted in Exhibit 11, as a knowledge pyramid. They have relative sizes derived from this fact:

> Our senses absorb many more experiences that influence our intuition more than we consciously realize, and we realize or reason much more than we ever articulate or share with others.

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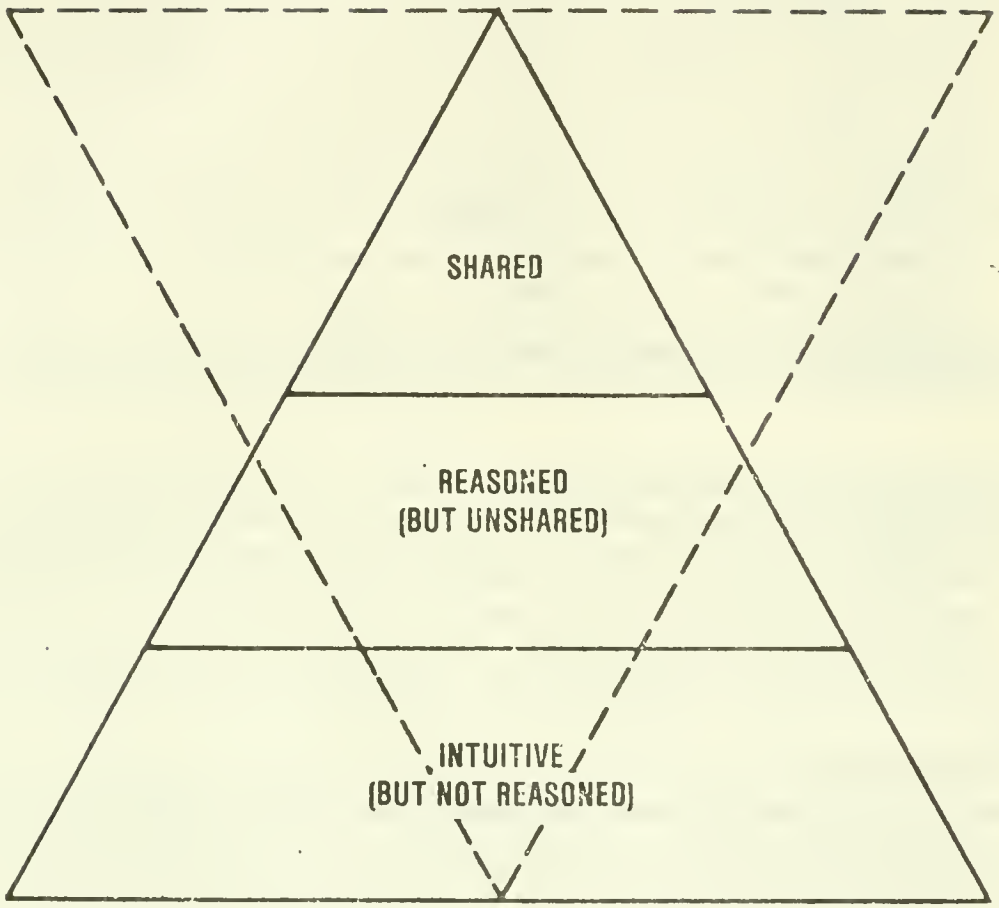
*A meta-rule is a decision rule which influences the formulation of many other decision rules.

EXHIBIT 11
KNOWLEDGE PYRAMID



However, it is not the **knowledge pyramid**, shown by solid lines in Exhibit 11, but rather a second inverted pyramid or **tool pyramid**, outlined there by broken lines, that is most reflected in this meta-rule, better called a **tool rule**. A few definitions are needed to elucidate concepts embodied in the tool rule:

TOOLS, as broadly defined here include not only technologies but also cultural or institutional forms. This broad concept, which is only approximated by the familiar word "tools," means any nonhuman embodiment of decision rules, which in human form we would recognize as **reflexes** such as removing one's hand when feeling that a stove is hot, **habits** such as pressing the brake in a car when seeing a red light, and conscious **decisions** such as buying because it is cheaper and seems to be the same in quality. In "tools" -- that is, in nonhuman forms — decision rules are: (a) built into **hardware**, for example, to trigger a heater to turn on automatically when a thermostat registers too low a temperataure; (b) programmed into **software** to trigger electronic branching, for example, to print out a bill when money is owed on some account; (c) embodied in **cultural or institutional** forms, such as laws which require punishments to be applied in response to violations.

SOCIETAL TOOLS draw mainly upon knowledge that can be fully articulated about changing situations and environments -- for example, technologies like jetliners that sometimes fly on automatic pilot, nuclear power plants where human intervention to control operations is rare and must only be based upon reasons that can be fully articulated, and laws which court proceedings articulate more fully than did legislatures when passing such laws.

TRANSACTIONAL TOOLS draw mainly upon knowledge that is unarticulated yet reasoned enough for the parties involved to know individually what advantages they are receiving from making transactions — for example, common carrier phone systems which connect parties only as long as they mutually gain from conversing, market exchange settings of various sorts where both parties to any trade individually sense benefits that need not be articulated, and new forms of many-to-many communication where many persons stay involved together only as long as they sense sufficient benefits to themselves individually.

PERSONAL TOOLS draw mainly upon feeling and/or intuitive knowledge so that their users may only "sense" that they (1) benefit from their use -- for example, hammers which can usually only be used by dexterous adults who cannot explain adequately to small children how they coordinate their actions so as to hit nails rather than fingers, or (2) merely enjoy their use, for example, homes where people may have long nested and from which they will

not move in spite of rational arguments, or the new personal computers which have many popular uses not justified by practical reasons but rather by the fact that they are entertaining hobbies.

All three types of tools — personal, transactional and societal — of course have considerable value. However, during the course of civilization thus far, personal and transactional tools have been undervalued in comparison to societal tools. By definition, the values of personal and transactional tools are more difficult to articulate and measure than the value of societal tools that are based upon more complete "blueprints."

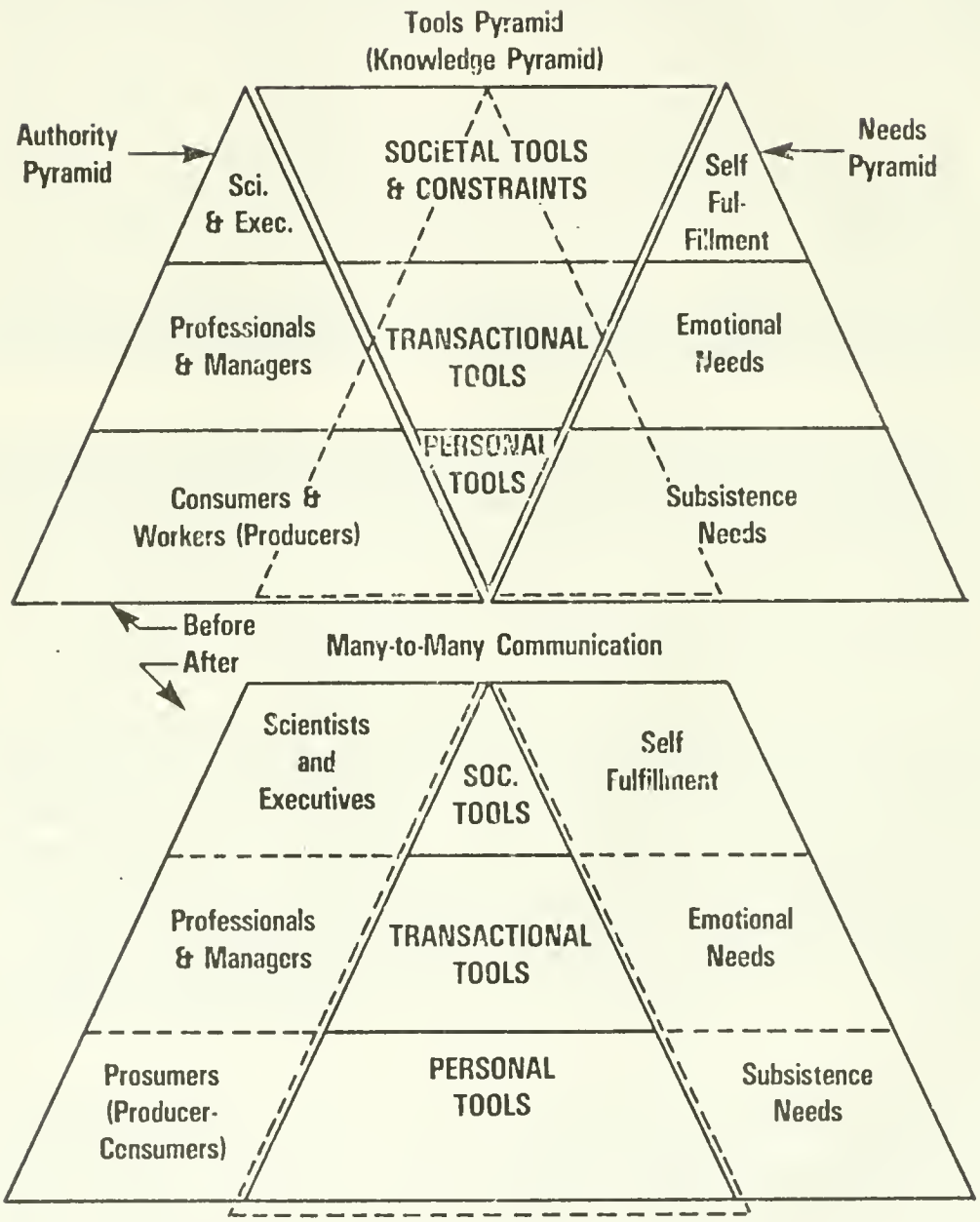
Now, many-to-many communication could help give us this inverted tool rule. Whereas:

> UP TO NOW, other things being equal, investment in and development of societal tools have been favored over transactional tools and even more over personal tools;
>
> FROM NOW ON, whenever in doubt, favor investment in and development of personal tools over transactional tools and even more over societal tools. In other words, the inverted tool-rule becomes humanized.

This inversion or transformation is illustrated in Exhibit 12, where, opposite to the way they were depicted in Exhibit 11, the **tool pyramid** is shown by solid lines and the **knowledge pyramid** in the background is shown by broken lines. The top and bottom halves of Exhibit 12 correspond to **before** and **after**, respectively. We will not dwell here on other transformational projections implied in Exhibit 12's other two, more familiar pyramids — depicting authority and needs, respectively — except to note that, after this projected transformation, greater upward mobility is implied both by the changes in the relative sizes of diagram sections and by the broken lines in the bottom diagram, on the left, separating scientists and executives both from professionals and managers and from producers and consumers, and, on the right, separating self-fulfillment both from emotional needs and from subsistence needs.

EXHIBIT 12

INVERSION OF [illegible]'S TOOL RULE



Such upward mobility should occur when more consumers and workers (or producers) start using many-to-many communication to apply their previously underutilized knowledge. Then they are likely to find themselves performing more functions that are similar to functions which only knowledge professionals, middle managers, top executives, and scientists now perform. This can be seen in the early application of office automation systems that contain limited capacities for many-to-many communication. Secretaries, the main workers or producers in many office environments, are asking and being asked to make more decisions of the sort which new interactive systems facilitate. And, some top executives are overcoming initial reluctance to sit themselves down at computer keyboards so that they can take fuller advantage of such interactive systems rather than interacting only through their secretaries and thus delaying those decisions which only they can make.

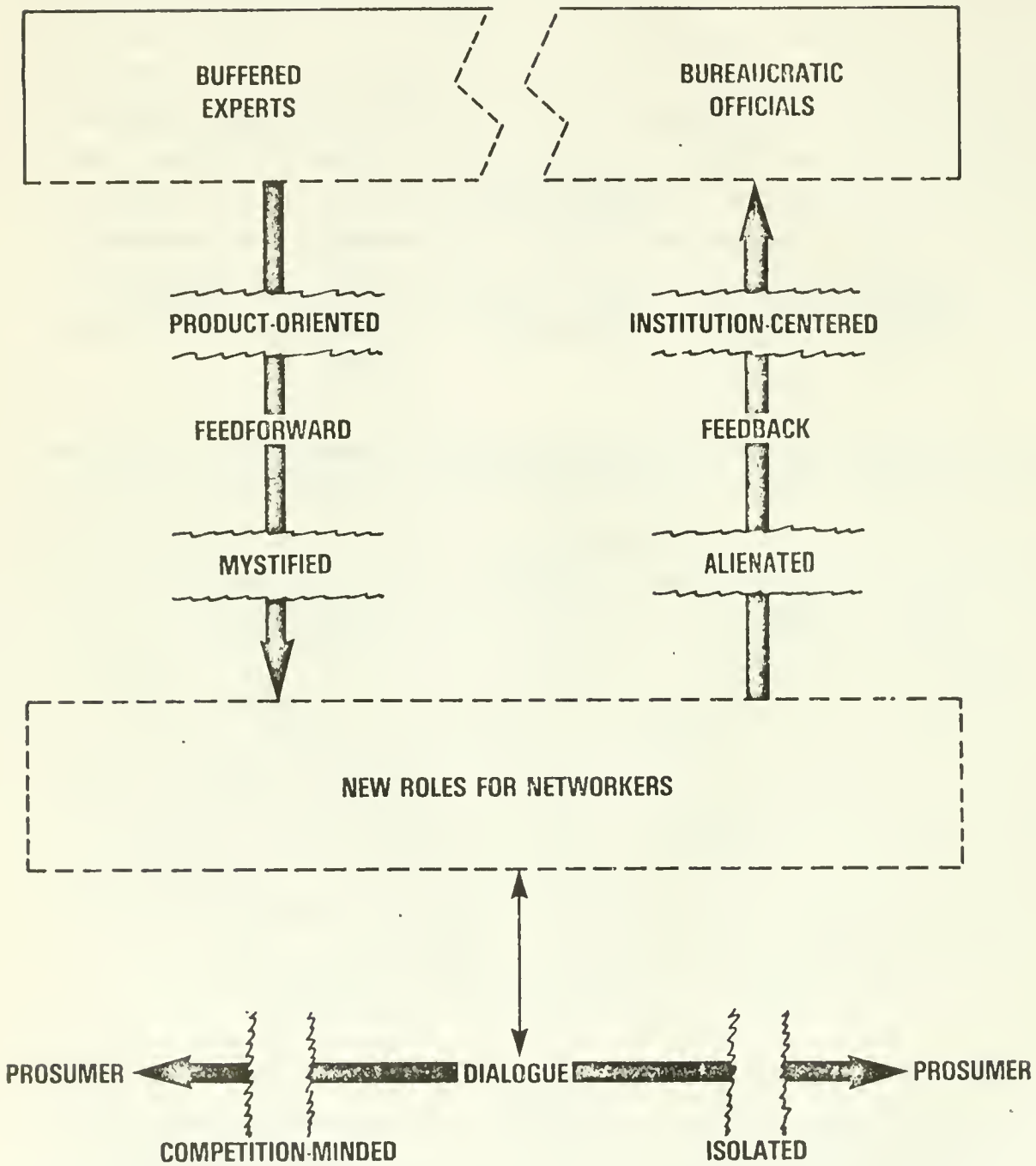
This transformation in roles can be expected to extend well beyond the walls of offices. Consider the transformation of relationships, attitudes and mindsets, as suggested in Exhibit 13. There, the top executives and middle managers, previously referred to separately, are now grouped together into the single category called "officials." And, scientists and knowledge professionals (e.g., doctors, lawyers, engineers, teachers, clergy, etc.) are in Exhibit 13 called "experts." All others — meaning people in their roles as citizens, consumers, and workers or producers -- are in Exhibit 13 called "prosumers," which Alvin Toffler in his recent book **Third Wave** has defined to mean a new role combining previous roles of "**pro**ducers" and "con**sumers**" made possible, in part, by what this paper calls "many-to-many communication or networking among people supported by computers."

Exhibit 13 depicts several aspects of this potential transformation of roles and organizations that need to be researched before many-to-many communication can beocme a well established or widespread phenomenon:

- The three principal communication **linkages** that need new emphasis and study are **feedback** from prosumers to officials, **feedforward** or advice from experts to prosumers, and **dialogue** among previously isolated prosumers.

EXHIBIT 13

TRANSFORMATION OF ROLES AND ORGANIZATIONS



- The **changes in organization** structure (depicted by broken lines in Exhibit 13) that are most needed are:

  -- to allow the feedback to **penetrate "bureaucratic" boundaries;**

  -- to **"buffer" experts** enough from officials to make the advice (feedforward) from experts be more credible to prosumers who use that advice to express value judgments in feedback to officials;

  -- to **define new roles for networkers** to facilitate, edit or otherwise improve processes of many-to-many communication.

- The **feelings** of powerlessness that currently inhibit early experiments in many-to-many communication need to be better understood, for example:

  -- **alienation** inhibiting feedback to officials who are thought not to care about prosumer opinions;

  -- **mystification** inhibiting the acceptance of feedforward from experts to prosumers, who often feel incapable of understanding the models used by experts in making the projections on which they base advice;

  -- **isolation** inhibiting dialogue among prosumers who are used to operating separately at the dangling ends of current production and consumption hierarchies.

- The even more serious inhibitions against many-to-many communication caused by more rationally based **mindsets** such as:

  -- **institution-centered** deferral by prosumers of the most important decisions to "officials" or "decision-makers";

  -- **product-oriented** view of prosumers that even education and health, for example, should be provided by "experts" -- in those cases, by doctors and teachers -- as well-packaged "products" rather than as interactive services, which require greater responsibility by the prosumer -- in this case by the student or by the patient.

  -- **competition-minded** view of prosumers that there may be more to gain from competing rather than from cooperating with other prosumers through group dialogue or many-to-many communication.

In summary then, if many-to-many communication is likely to provide the basis for some sort of societal transformation, then it would be prudent now to study new communication linkages and where the transformation

associated with such linkages may be leading. We must also recognize what traditional roles, structures, attitudes and mindsets might be most affected by such a transformation.

The roles that seem most pivotal for now are the roles of executives and of knowledge professionals as the most likely initial users of new forms of many-to-many communication. Some current middle management roles, may be transformed into new networking facilitation roles. (This is already occurring.)

Many-to-many communication makes scientists of us all, to some extent. The scientific method has always used some of the techinques that are now becoming accessible and applicable to many others, and that idea will now be explored.

7. THE POTENTIAL

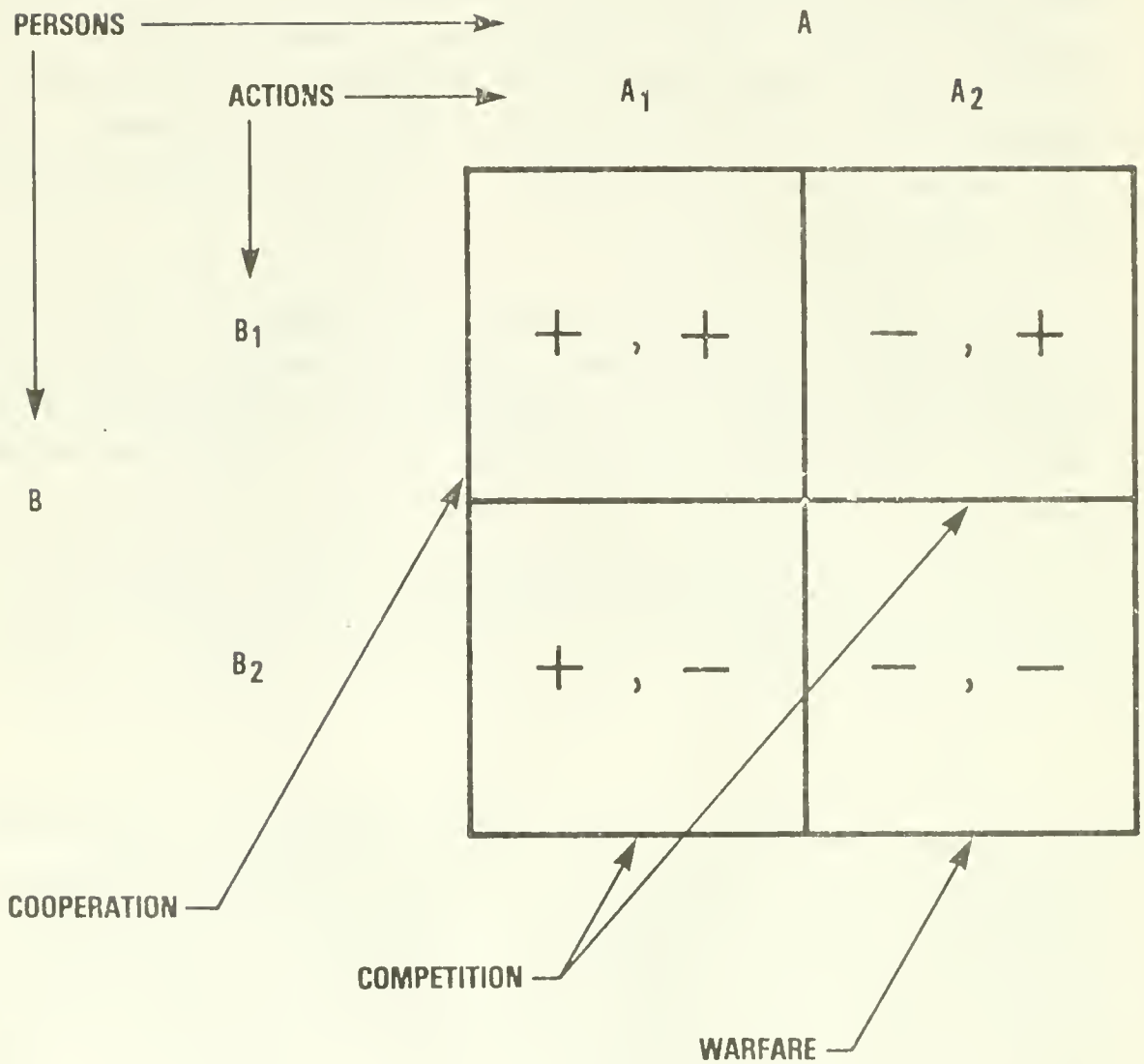
Towards an Infonomic (Information Economic) Theory of Productivity and Innovation...

The **transformation** discussed in the previous section is not likely to occur unless the **potential** of many-to-many communication is realized enough to motivate that transformation. In this section, we will consider many-to-many communication in terms of why it may become an important new source of productivity, innovation, and profit. Also, this section focuses upon **executives** and **scientists**, because (a) it has traditionally been the role of **executives** to pursue such new sources of potential profit; (b) the application of many-to-many communication to support the communication-dominated work of top **executives** is expected to have the greatest potential in this decade; (c) the inquiry methods used by **scientists** will become more prevalent through many-to-many communication; and (d) those **scientists** researching and developing many-to-many communication should practice the networking facilitation that they preach and move from domination of to support of **executives** in developing their own systems for many-to-many communications or **executive support systems.**

To understand how best to provide support for many-to-many communication among executives, we must first agree that a fundamental function of executives is that of **coordination.** A simple view of coordination can be derived from economic game theory, as shown in Exhibit 14. The plus and minus signs stand for positive and negative payoffs achieved for the two "players" or "actors" denoted by A and B. For example, "+, -" means A wins and B loses while "-, +" means A loses and B wins.

The main reason why enterpreneurial executives form and/or run corporations is because they (and their associates) determine that through cooperation they can achieve more for themselves (and, if

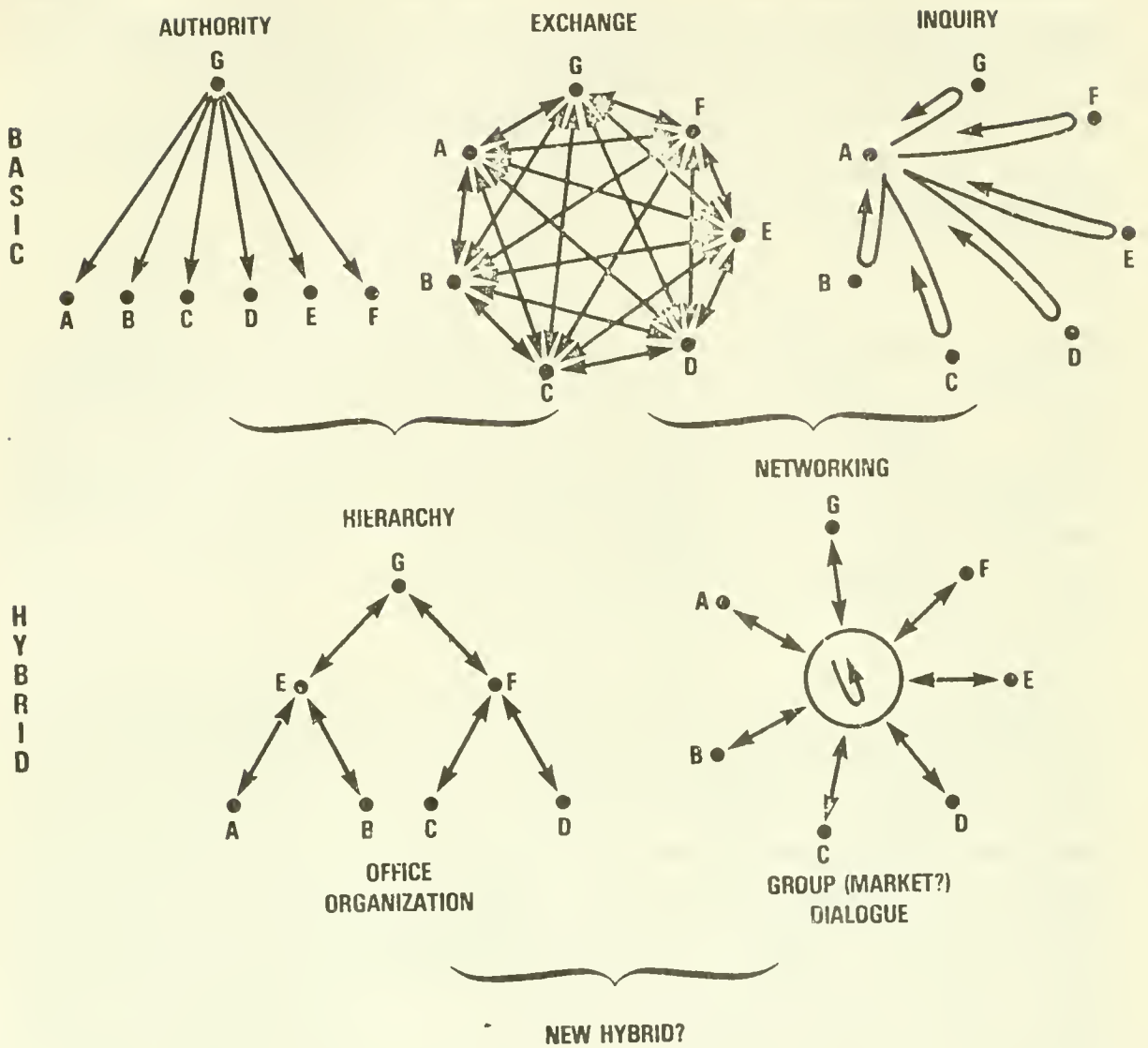
EXHIBIT 14
GAME THEORETIC VIEW OF COORDINATION



altruistic, for others as well) in a corporate setting than they could otherwise. To understand why and how, let us consider the hierarchical communication structure that most often is used to describe corporate organizations.

EXHIBIT 15

BASIC & HYBRID FORMS OF COORDINATION



When viewed in game theoretic terms, hierarchies appear to be derived from two more basic forms of coordination — authority and exchange. Authority today, as well as in ancient times, mainly implies avoidance of at least internal warfare (-,-) and achievement of some degree of internal cooperation (+,+) through instructions being given "from the top." Whereas exchange, as probably first became apparent when mercantilism became nearly as powerful a force as the authority of kings, achieves cooperation (+,+) by mutual consent of two or more parties. Authority, exchange and hierarchy are shown in Exhibit 15.

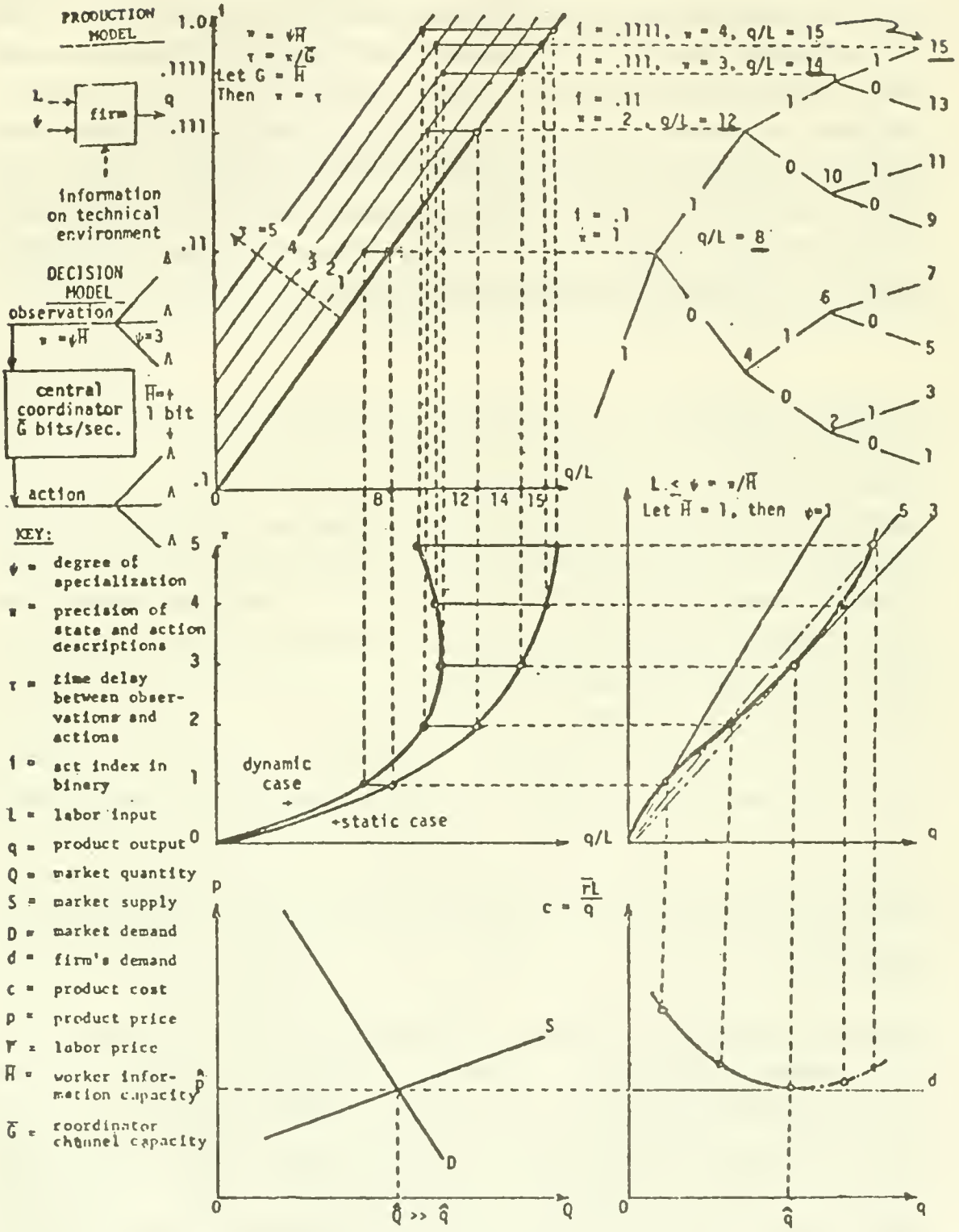
As Exhibit 15's depiction of exchange is meant to imply, unsupported processes of exchange are not efficient enough to achieve widespread coordination among many people at the same time. Hierarchy, as a hybrid of authority and exchange can and does achieve much wider cooperation among the many who, for example, are employed within any hierarchical corporation. Before considering other aspects of Exhibit 15, we must further examine hierarchy.

Economic theory offers only one explanation of why hierarchical firms in competitive industries are limited in size in the long run, when all factors of production such as labor and capital are variable. It is theorized that the gains to specialization as a firm grows in size are eventually outweighed by problems of coordination. An interpretation of that theory is shown in Exhibit 16.

At the bottom of Exhibit 16 are shown the familiar economic diagrams for supply and demand within any industry and long-run average cost of production within a single firm in that industry. Please note that just above the long-run average cost curve is the "production function," also familiar to economists but usually depicted with the product quantity (q) and the labor input (L) axes being the reverse of the way shown here. The remaining three diagrams of this six-diagram exhibit are derived more from information theory than from economic theory. Starting in the upper right diagram, a simple binary tree is used to depict how additional bits of precision can lead to higher and higher payoffs as one moves from left to right along this tree or from the mid-point to progressively higher points on the static payoff line through the origin of the corresponding diagram in the upper left of Exhibit 16. In essence, the firm would achieve the average of the payoffs of whatever more precise actions it could take if it "knew" more about its environment through greater specialization among its employees. However, the actions of specialized employees need to be coordinated because the firm's environment is never static; rather, it changes continually, as illustrated by the shifting line over time in

EXHIBIT 16

INDUSTRIAL ERA FIRM SIZE, SPECIALIZATION & COORDINATION



the upper left diagram. The model in this exhibit for coordination within a firm consists simply of a single centralized coordinator receiving observations from and issuing instruction to specialists. The limited channel capacity of the central coordinator for processing these observations and instructions is what causes delays to get longer as precision achieved through greater specialization gets higher. Thus there is a tradeoff between being precise and being timely, since a more precise action to be taken in a more precisely observed enviroment is of less rather than more value if the environment changes considerably before the more precise, coordinated action can be taken.

This model corresponds to the general impression that smaller firms, even though able to achieve less internal specialization, may have advantages over larger firms in rapidly changing industrial environments because the smaller firms may be more flexible in making quicker decisions. Of course, size is only one of several dimensions of organizational structure, another being the varying degrees of centralization or decentralization that can be achieved within hierarchical organizational structures.

Referring back now to Exhibit 15, with the advent of many-to-many communication, or networking, we need to understand not only how coordination is achieved through hierarchy but also through networking and perhaps some yet to be developed combination of hierarchy and networking.

Networking itself is, in Exhibit 15, depicted as a hybrid of the more basic forms of coordination — exchange and inquiry. Inquiry is as old as authority and exchange, even though it is seldom thought of as a form of coordination. Socrates used inquiry to explore with others what seemed to be in their mutual self-interest -- in other words, what cooperation (+,+) they might program into their philosophy, culture, institutions, laws, etc. Inquiry became more formal when Aristotle began developing what has come to be known as the "scientific method"

and when judges began conducting judicial inquiries of various sorts. If we were, however, to depict inquiries in the upper right diagram as being able to be conducted by anyone or everyone, that diagram would become even harder to see than the crowded exchange diagram next to it. Thus we have shown inquiry lines stemming from only one inquirer. Let us suppose these represented an opinion pollster or market researcher who wants to determine what single policy or single product in some area might best satisfy most people. Scientific sampling and other research methods make such an effort more manageable and more efficient. But so does computer networking, which might even allow limited methods of "scientific inquiry" to be employed by non-scientists. This, I believe, is in part what many-to-many communication can achieve as a new means of coordination.

As a hybrid, many-to-many communication or widespread networking among people is dervived from exchange as well as from inquiry, both being more basic forms of coordination. Networking will achieve recognition as a formal means of coordination as the shared computer memories employed to support many-to-many communication become more accessible. In the meantime, research is urgently needed about the **nature of inquiry, about formal networking as a hybrid of exchange and inquiry, and about the potential new hybrid which may result** from combining hierarchy and networking as forms of coordination.

The potential of formal networking among people for improving both productivity and innovation is what needs the most immediate research attention. The rudimentary abstractions discussed in this section imply that networking could have considerable impact on productivity (see the derived "production function" in the middle right diagram in Exhibit 16) and on innovation (see "inquiry" as underlying the hybrid of "networking," both on the right in Exhibit 15). Since innovation and productivity are the basic forces which underlie new corporate profits, the prospect of productivity and innovation improvements should motivate executives to invest in developing many-to-many communication.

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